RURAL INDUSTRIES RESEARCH
& DEVELOPMENT CORPORATION

Emu Products

Increasing Production and Profitability

A report for the Rural Industries Research and Development Corporation

Part A by P O'Malley
Parts B and C by P O'Malley and JM Snowden
Agriculture Western Australia

December 1999

RIRDC Publication No 99/143
RIRDC Project No DAW-57A

ISBN 0 642 57907 5
ISSN 1440-6845

Emu Products – Increasing Production and Profitability
Publication No. 99/143
Project No. DAW-57A

Researcher Contact Details
Peter O'Malley
Agriculture Western Australia
Locked Bag No 4
Bentley Delivery Centre WA 6983

Phone: 08 9368 3577
Fax: 08 9474 1295
Email: peterom@aidpo.agric.wa.gov.au

RIRDC Contact Details
Rural Industries Research and Development Corporation
Level 1, AMA House
42 Macquarie Street
BARTON ACT 2600
PO Box 4776
KINGSTON ACT 2604

Phone: 02 6272 4539
Fax: 02 6272 5877
Email: rirdc@rirdc.gov.au
Website: http://www.rirdc.gov.au

Published in December 1999
Printed on environmentally friendly paper by Canprint

Foreword

The objective of this project was to increase sales and returns from emu oil through improvements in the quantity and quality of fat produced per bird and to increase sales and returns from emu skins by reducing skin damage and the introduction of an objective skin classification system.

Part A of this report documents the impact of season on the growth of emus hatched from July to November and the effect of feed restriction on seasonal appetite. The data presented will enable the formulation and costing of production strategies which maximise the production of emu oil and meat throughout the year.

Part B of this report presents research which investigates the possibility of using alternate techniques for the de-clawing of emus and describes a refinement of technique which allows a pad of tissue to develop at the tip of the de-clawed toe. It further documents what effect de-clawing emu chicks at hatch has on feed consumption, growth and blood heterophil/lymphocyte ratio.

Part C of this report presents research into existing emu oil patents, assesses their effect on future oil research, demonstrates the efficacy of emu oil within existing anti-inflammatory models and evaluates rat models and other biological and chemical analysis as a means of demonstrating efficacy within emu oil samples.

The report, a new addition to RIRDC's diverse range of over 400 research publications, forms part of our New Animal Products R&D program which aims to facilitate the development of new industries based on animal or animal products that have commercial potential for Australia.

Most of our publications are available for viewing, downloading or purchasing online through our website:

- downloads at www.rirdc.gov.au/reports/Index.htm
- purchases at www.rirdc.gov.au/pub/cat/contents.html

Peter Core
Managing Director
Rural Industries Research and Development Corporation

Contents

Part A

Production of Oil and Meat

by Peter O'Malley
Agriculture Western Australia

CONTENTS

Executive Summary

This part of the project focused on gathering data on the growth of emus hatched from July to November and the use of feed restriction to overcome the current production restraints imposed by the emus marked seasonal appetite changes. A clear understanding of the interaction of age, growth, appetite and season is needed to formulate production strategies to maximise the production of oil and meat.

Growth and feed consumption of emus hatched mid July, August ,September, October and November were recorded from hatch to slaughter. They were slaughtered at near optimum live weight after finishing on either a low or high energy finisher diet.

All hatches experienced a decline in appetite and growth during the autumn and reached a peak in live weight in mid December irrespective of age. The feed saving expected by being able to slaughter late hatched birds at a younger age than the earlier hatched birds did not eventuate as the late hatched chicks still experienced a slow down in growth during their first autumn and plateaued at a lower finishing weight.

Early hatched birds gained weight rapidly until autumn when growth slowed at 25 to 35 weeks of age. Low levels of growth were recorded throughout the winter months until late spring stimulated appetite and growth at 50 - 55 weeks of age. Maximum live weight was reached in mid November at 65 - 70 weeks of age.

Late hatched birds initially grew at a similar rate to the early hatched birds but growth slowed as they approached autumn at the younger ages of 10 - 15 weeks. Throughout winter they maintained higher rates of gain than the earlier hatched birds and responded to the stimulus of spring earlier when 30 -35 weeks of age. They reached a lower maximum live weight in mid December at 50 - 55 weeks of age.

At slaughter the later hatched birds produced similar amounts of fat but yielded 500 grams less muscle. All hatches ate a similar amount of feed to slaughter.

The feeding of a high energy finisher diet yielded a kilogram more fat at slaughter and where it is cost effective low protein high energy finisher diets can be fed.

A second trial showed there is considerable advantage in restricting the diet of emus, particularly those destined for slaughter at ages older than 12 months, until 2 - 3 months prior to slaughter.

Emus restricted fed so as to maintain an average live weight of 32.5 to 38.4 kilogram can be fattened and slaughtered at an average live weight of greater than 45 kilograms from April to August within 8 weeks of feeding a high energy finisher diet ad-lib.

Each bird consumed approximately 75 kilograms of finisher ration to achieve a slaughter weight of greater than 45 kilograms. Cumulative feed consumption of the restricted fed birds after the 8 week full feeding period was similar to full fed controls and there was no overall saving in feed. They were however, heavier and could be expected to yield about 2 kilograms more fat at slaughter.

Restriction did not completely eliminate the effect of season and the restricted birds full fed in February did not show the same level of response as birds full fed later in the year. There was also a trend for the response to increase as the birds approached their normal fattening season.

While the feed restriction did reduce egg production it did not completely eliminate it. Results also suggest that it could be possible to commence restriction at even lower live weights without any detrimental effect on final live weight and product yields.

Results suggest that fatness is not directly linked to sexual activity and that the physiological mechanisms controlling seasonal appetite are independent of those controlling seasonal breeding.

Date of hatch and sex of the birds had no effect on the way the birds responded after the feed restriction was lifted.

The information presented in the report can be used to model the most profitable production options for a range of industry price and cost structures. Partial analysis showed that for a wide range of product prices income will be maximised when birds are slaughtered between 56 and 72 weeks of age with the earlier hatched birds being full fed and slaughtered first and the later hatches being restricted fed from 32.5 kilogram live weight and slaughtered at the older ages after being finished on a high energy finishing ration for 8 - 12 weeks. Although this will confine the supply of fresh product from September to May each year the killing of birds outside this age range has a considerable cost penalty.

Season impacts on the appetite of even very young emus during their first year of growth and further research on the use of restricted feeding to overcome the autumn - winter appetite suppression seen in early hatched yearlings may also show a benefit by allowing them to be fattened during autumn - winter and slaughtered at a younger age at reduced cost.

It is clear from this and previous work that emus fed to appetite will carry high levels of fat reserves and much of the live weight growth recorded for young emus is growth in body fat rather than muscle. Birds with good reserves of fat reduce appetite and growth during autumn - early winter and utilise much of the stored fat before appetite increases again in the spring. It is also known that emus have the ability to consume large volumes of food relative to live weight and the development of cheaper production systems based on lower input browse or pasture feeding prior to fattening for oil production appears possible.

Background to the Project

At the commencement of the project specific legislation to permit the commercial farming and slaughter of emus had been enacted in all states of Australia. Western Australia had been farming for 7 years and its commercial flock had grown to 32,500 birds. Commercial farms were established in Queensland and Tasmania in 1992 and in New South Wales in 1993. While Victoria and South Australia had only just enacted legislation sizeable flocks had existed in South Australia under wildlife legislation since 1991. In total there were 25-30,000 emus of breeding age and 35,000 juveniles being farmed throughout Australia and within three years an annual production of more than 125,000 emus was possible.

Although Western Australia had been selling emu products since 1991 annual slaughtering for product for 1992/93 and 93/94 had been only 5,491 and 5,696 birds respectively and the industry appeared preoccupied with the live bird market. At this level of supply the meat sold well as a low fat, low cholesterol, high protein gourmet meat, emu oil was being sold as a medicinal oil for the relief of joint pain, soft tissue injury and dermatitis and as a base for a range of cosmetics. Body and leg skin was being manufactured into high quality exotic leather but skin damage and subsequent tanning problems had stalled the development of the market and quantities of sub standard skins were being stockpiled.

The demand for oil at that time was firm and the market was expected to increase dramatically when the therapeutic properties of the oil were proven. Emu Products Western Australia Pty Ltd, a Western Australian Company, had registered patents on emu oil and had undertaken research to identify the active ingredient. The company agreed to cooperate in research which aimed to maximise the quantity of fat being produced by the bird and optimise the level of the identified active ingredient in the oil. ie. maximise quantity and quality of oil produced.

Within 12 months of the commencement of the project it became apparent that Emu Products Australia Pty Ltd did not possess the ability to identify therapeutically active oils and as oil was identified as being the product that could lead to a long term future for the emu industry, the industry negotiated for more specific work on the therapeutic properties of the oil to be carried out. Principally this involved an assessment of the existing emu oil patents, preparation of a number of research briefs investigating the medicinal properties of the oil and an evaluation of the rat model and other biological and chemical analysis as a means of demonstrating efficacy within emu oil samples.

Fat is an expensive commodity to produce and emu farming practices which maximise its production or alternatively optimise the returns from both fat and meat need to be developed. It is known that an emus' appetite and rate of growth respond strongly to season and during the first 18 months of life these interact with date of hatch. Work was undertaken to clearly define the impact of hatch date on growth and the effect of feed restriction on subsequent fat deposition.

Emu Growth and Fat Deposition

Effect of Hatch Date on Emu Growth

Emu chicks are hatched seasonally from July to November with numbers peaking in September. Initial growth is rapid and well grown birds can reach 20 kilograms live weight by 24 weeks of age with a conversion of feed to live weight of 3 : 1. Beyond this age consumption plateaus or reduces and growth slows during the autumn winter months until the birds commence to fatten at 40 weeks of age. Peak fatness is reached at about 60 weeks of age.

The age at which season impacts on the birds appetite and growth is dependent on its hatch date and the growth curve for each hatch is likely to be different. It presents the opportunity for some hatches to be more efficient in the production of meat or fat and the possibility of the development of different feeding strategies to produce different products from selected hatches. While scientific thinking suggested that birds hatched late in the season should be the cheapest to produce because they would not experience the period of low winter appetite seen in early hatched birds and fatten for slaughter at a younger age, industry reported that latter hatched birds generally grew poorly and were difficult to finish. Information on the effect of hatch date on growth can also be used to estimate the likely benefit of the development of technologies to remove the effect of season on emu growth.

Objective

To determine the effect of hatch date on emu growth, age at peak fatness and yield of meat and fat.

Experimental Method

Five batches of emu chicks were hatched every 4th week from July 22 to November 11. A minimum of 3 replicates of 20 chicks were randomly housed in 4.65 X 1.83 metre indoor pens and brooded at 27 - 28 ° C. At 6 weeks of age birds were moved to 4 X 4 metre indoor pens. Numbers were reduced to 12 birds per pen at 12 - 16 weeks of age and the birds re-housed in 20 X 3 metre outdoor pens. The birds were then moved to larger 20 X 40 metre pens and numbers reduced to 10 per pen on the February 14 when the first hatch was 29 weeks of age. Bird adjustments were done from within weight strata so as to maintain average pen weight and live weight distribution.

Live weight was recorded every 2 weeks for the first 6 weeks of age, and monitored as frequently as resources allowed until the birds approached slaughter weight when fortnightly weighings were made.

Feed was fed ad-libitum for 2 weeks and then feed access was restricted to 7.30 am to 1.30 pm each day until 6 weeks of age.

Feed issued was recorded and the amount of feed eaten determined at each weighing date. Replicate feed weighings were not possible during the period the birds were housed in the 4 X 4 indoor pens.

To 42 weeks of age all hatches were fed the same series of rations, according to age, mixed on the research station. From 42 weeks of age 2 replications of each hatch were to be fed a low energy finishing ration, 2 replications a high energy finishing ration and 1 a high energy, low protein finisher ration (Table). Hatches 1 & 2 were in fact fed the finisher diets from 23 June (47 and 43 weeks of age, Hatch 3 from 11 July (42 weeks) and hatches 4 & 5 from 7 August (42 and 38 weeks).

Ingredient	0 - 6 Weeks	6 - 12 Weeks	12 - 24 Weeks	24 - 40 Weeks	40 - 60 Ration **1**	40 - 60 Ration **2**	40 - 60 Ration **3**
Wheat	50.5	55.0	64.0	72.0	65.15	58.8	69.0
Oats	15.0	15.0		5.0	10.0	9.0	12.0
Barley			10.0	7.0	9.0	8.0	8.5
Oats (Dehulled)		5.0					
Bran	7.0						
Pollard	1.0	5.0					
Lupin	10.0	10.0	13.0	5.0	1.0	1.0	
Meatmeal	9.0	6.5	10.0	7.5	7.7	7.0	
Bloodmeal							0.50
Dry Sawdust						14.4	
Lime sand	0.25	0.66	0.44	0.1	0.64	0.6	1.12
Dicalc phos	1.33	1.30	0.84	1.5	0.65	0.6	2.43
Canola oil	0.42	1.00	1.00	1.00	5.00		5.5
Salt	0.22	0.200	0.17	0.20	0.23	0.210	0.34
Lysine	0.024	0.80	0.019	0.090	0.090	0.081	0.215
Methionine	0.155	0.073	0.162	0.126	0.110	0.099	0.091
Min vit	0.250	0.250	0.250	0.250	0.250	0.225	0.250
Choline (50%)	0.200	0.200	0.200	0.200	0.200	0.180	0.200
Total	100	100	100	100	100	100	100
Calculated analysis							
Energy MJ/kg	11.0	11.8	12.2	12.5	13.27	10.47	13.27
Protein %	16.5	15.7	17.5	15.0	13.69	12.34	10.64
Lysine %	0.76	0.74	0.79	0.69	0.65	0.58	0.55
Methionine%	0.38	0.30	0.39	0.35	0.37	0.29	0.27
TSAA%	0.67	0.60	0.69	0.62	0.58	0.52	0.51
Calcium%	1.20	1.00	1.20	0.97	1.01	0.93	1.00
Avail. Phos%	0.65	0.55	0.73	0.60	0.47	0.43	0.47

Commercial slaughter arrangements meant that the birds were slaughtered on three separate dates as they reached peak fatness. Four replications from each of the July and August hatches were slaughtered on 1 November, the remaining replicate from these hatches and the

September hatch were slaughtered on 22 November and the October and November hatches were slaughtered on 24 January.

Carcase, Muscle and total fat weight was recorded at slaughter.

Results

Mortality

In order to reduce early mortality caused by leg problems the birds access to feed was restricted to four hours each day from two to six weeks of age. Mortality to six weeks is presented in Table 1.

Table 1

Mortality
(Birds to 6 weeks of age)

	Hatch 1	Hatch 2	Hatch 3	Hatch 4	Hatch 5
Deaths	3	4	1	0	1
Leg Culls	0	1	3	2	2
Flock size	76	66	64	62	60

Hatches 3 and 4 showed symptoms of a respiratory challenge which peaked at 4 weeks of age. Mortality from this cause was minimal and birds showing symptoms had recovered by six weeks of age.

At 4 - 5 weeks of age a number of birds in hatch 5 developed slight ataxia and shaking when disturbed and showed abnormal feather development. A similar condition was seen in a number of commercial flocks and inadequate manganese nutrition was suspected. The flock was removed from restriction at 5 weeks of age and recorded growth rates similar to other flocks. Birds continued to display symptoms and 1 bird was culled at 17 weeks of age because of poor growth and another because of bent legs.

Mortality from leg problems did not exceed 2 percent.
Subsequent mortality for all hatches was low and caused by accident or pen fighting.

Live Weight, Feed Consumption and Daily Gain

Pen average live weight, feed consumption and gain at each age are tabled for each hatch in Tables 2 - 10. Pen average live weight, feed consumption and gain on a seasonal basis are tabled in Tables 11 - 16.

Table 2

Pen Average Live Weight of Emus Hatched July - November

0 - 21 Weeks of Age (grams)

Weeks	0	2	4	6	8	10	12	13	14	15	16	17	18	19	20	21
Hatch 1	21-Jul	3-Aug	19-Aug	2-Sep	16-Sep	29-Sep	14-Oct		28-Oct				25-Nov			
	426	648	1057	1593	3459	4971	6967		9271				13748			
	414	708	1240	1727	3767	5265	7352		9458				13770			
	416	629	1057	1703	3460	4874	6995		9070				13472			
Average	**419**	**662**	**1118**	**1674**	**3562**	**5037**	**7105**		**9267**				**13663**			
Hatch 2	17-Aug	31-Aug	16-Sep	29-Sep		28-Oct			25-Nov							
	400	732	1526	2065		5676			9788							
	389	766	1597	2139		5905			10205							
	437	745	1548	2066		5725			9929							
Average	**409**	**748**	**1557**	**2090**		**5769**			**9974**							
Hatch 3	16-Sep	29-Sep	14-Oct	28-Oct	11-Nov	24-Nov		16-Dec							7-Feb	
	420	606	997	2006	3537	5900		8036							16069	
	438	647	1220	2175	3720	6178		8644							16008	
	438	595	1054	1910	3372	5640		7670							16692	
	453	609	1064	2163	3504	5911		8200							15531	
	434	596	1057	2167	3563	6264		8436							16013	
	445	605	1092	2064	3523	5990		8180								
Average	**438**	**610**	**1081**	**2081**	**3537**	**5980**		**8195**							**16063**	
Hatch 4	14-Oct	28-Oct	11-Nov	25-Nov							7-Feb			28-Feb		14-Mar
	426	701	1353	2164							11142			14727		17133
	410	722	1432	2299							11964			14546		16708
	429	686	1380	2291							12718			15538		18008
	412	644	1315	2178							11617			14685		16892
	450	673	1285	2135							11938					
Average	**425**	**685**	**1353**	**2213**							**11876**			**14874**		**17185**
Hatch 5	11-Nov	25-Nov	9-Dec				7-Feb			28-Feb		14-Mar		28-Mar		11-Apr
	424	636	1204				6927			10467		13167		14417		16175
	429	622	1164				6293			9325		12000		12975		14713
	406	577	1171				6350			10043		12023		13275		14946
	414	720	1402				5907			10044		11817		13473		15100
										10567		13118		14745		16230
Average	**418**	**639**	**1235**				**6369**			**10089**		**12425**		**13777**		**15433**

Table 3. Pen Average Live Weight of Emus Hatched July - November

23 - 44 Weeks of Age (grams)

Weeks	23	24	25	26	27	28	29	31	32	35	36	38	40	42	44
Hatch 1							14-Feb	21-Feb	7-Mar	22-Mar		21-Apr		16-May	
							23307	24073	24493	26057		28007		29315	
							22993	23618	24038	25217		27264		28512	
							23800	24816	25236	26336		27900		29450	
							23157	23930	24350	25793		27671		29079	
							23636	24809	25229	26129		27879		29408	
Average							**23379**	**23801 a**	**24669**	**25906**		**27744**		**29153 c**	
Hatch 2				14-Feb			7-Mar	22-Mar		21-Apr		16-May		14-Jun	
				21450			23233	24483		26825		28033		30283	
				20291			22027	23218		25564		27327		29300	
				21133			23033	24383		26708		27900		29683	
				21692			23392	24808		27117		28717		30967	
				20958			22608	23817		26075		27475		29500	
Average				**21105**			**22859**	**24141 a**		**26458**		**27890**		**29947 b**	
Hatch 3	28-Feb		14-Mar		28-Mar			21-Apr		16-May		14-Jun		11-Jul	
	18385		21212		20317			22447		24429		27200		29400	
	18146		20522		20389			22700		24400		26856		29100	
	19138		21885		21862			24392		25854		27392		29800	
	18069		20238		20242			22562		23631		25808		28654	
	18600		21175		20713			23625		25014		27975		30513	
Average	**18468**		**21006**		**20705**			**23145 ab**		**24666**		**27046**		**29493 bc**	
Hatch 4	28-Mar		11-Apr			2-May		23-May	30-May		27-Jun		25-Jul	7-Aug	
	18020		19729			21613		22652	22973		26920		28960	29170	
	17169		18662			20354		21687	22008		24800		27369	28820	
	18977		20631			22385		23333	23654		27523		29746	29870	
	17415		18915			20815		21340	21662		24931		27408	29970	
														30090	
	17895		**19484**			**21292**		**22254 b**	**22574**		**26043**		**28371**	**29584 bc**	
Hatch 5		2-May				30-May		20-Jun	27-Jun		25-Jul	7-Aug		5-Sep	18-Sep
		18433				20875		23820	24733		28167	28508		31611	34460
		16538				18867		21272	22186		25157	26957		29730	31360
		17038				19608		21724	22638		25085	25762		31970	34650
		17500				18800		21932	22845		25673	26391		30420	32040
		18860				20517		23614	24527		26055	27500		31050	33290
Average		**17674**				**19733**		**22473 b**	**23386**		**26027**	**27024**		**30956 a**	**33160**
SE								**803**						**559**	
LSD (p<0.05)								**1063**						**788**	

Treatment averages in columns followed by a common letter are not significantly different (p>0.05)

Table 4. **Pen Average Live Weight of Emus Hatched July - November**

46 -69 Weeks of Age (grams)

	46	48	50	52	54	56	58	60	61	62	64	65	66	68	69
Hatch 1	14-Jun		11-Jul		7-Aug		5-Sep	18-Sep		5-Oct	18-Oct		31-Oct	14-Nov	21-Nov
Ration 1	31930		34309		36109		39073	41364		43073	43945		45410		
2	31644		32200		35078		38800	40775		41900	41925		43600		
1	30467		32189		33789		37000	38989		40589	41600		43033		
2	31967		31744		32956		37278	38467		41856	42500		43730		
3	31740		33944		37322		39944	40800		42044	42056		43222	43611	43833
	31550 c		**32877 d**		**35051 c**		**38419 b**	**40079 b**		**41892**	**42405**		**43799**	**43611**	**43833**
Hatch 2	11-Jul		7-Aug		5-Sep	18-Sep	5-Oct	18-Oct		31-Oct	14-Nov	21-Nov			
Ration 1	31744		35056		39222	41178	43590	43790		45400					
2	32818		34490		40436	41545	43270	44220		45170					
1	31920		33420		37670	39100	40113	41313		43550					
2	32800		34888		40138	40767	42767	43644		44444					
3	31860		34020		38289	40467	43144	43944		45333	46667	46578			
Average	**32228 bc**		**34375 c**		**39151 b**	**40611**	**42577 a**	**43382 a**		**44780**	**46667**	**46578**			
Hatch 3	7-Aug		5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	21-Nov						
Ration 1	33356		36732	39510	42060	42810	43580	44750	43920						
2	32940		37430	39590	42060	43160	43870	45650	43270						
1	31560		34760	36890	39540	40650	41760	42910	46270						
2	31711		35088	36150	36413	37613	39513	41775	42425						
3	33620		37590	39500	41240	40870	41840	42200	42870						
Average	**32637 bc**		**36320 b**	**38328**	**402623 ab**	**41021**	**42113 a**	**43457 a**	**43751**						
Hatch 4	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	28-Nov	12-Dec		27-Dec	9-Jan		23-Jan		
Ration 1	32170	34720	36510	37390	39300	39350	39075	38938		39713	40575		41388		
2	34180	36400	38070	39210	40300	40600	41450	42180		42450	41988		42363		
1	32940	34130	36400	38056	39067	40822	41644	39700		43550	43838		44375		
2	33400	35210	38100	36075	36150	38488	39650	40925		41671	41929		42486		
3	34060	35660	37930	38780	39300	40200	40170	41000		42000	42300		43038		
Average	**33350 b**	**35224**	**37402 ab**	**37902**	**38823 b**	**39892**	**40398 ab**	**40549 b**		**41877**	**42126**		**42730**		
Hatch 5	5-Oct	18-Oct	31-Oct	14-Nov	28-Nov	12-Dec	27-Dec	9-Jan		23-Jan					
Ration 1	37080	38030	38530	39920	40830	42140	42638	42600		42463					
2	36860	37530	38980	40600	42160	42430	43850	43838		44500					
1	34470	35300	37100	38530	39950	40010	39275	39013		39288					
2	35520	37170	38130	40240	41330	41670	42588	42838		43788					
3	35700	37870	39100	41640	42170	42450	41463	41300		42088					
Average	**35926 a**	**37180**	**38368 a**	**40186**	**41288 a**	**41740**	**41963 a**	**41918 ab**		**42425**					
SE	**917**		**992**	**1608**	**1862**	**1805**	**1789**	**1610**		**1501**	**1435**		**1351**		
LSD ($p<0.05$)	**1292**		**1398**	**ns**	**2624**	**ns**	**2521**	**2269**		**2189**	**ns**		**ns**		

Table 5. **Pen Average Feed Consumption of Emus Hatched July - November**

0 - 20 Weeks of Age (grams/bird/day)

Weeks	**0**	**2**	**4**	**6**	**8**	**10**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Hatch 1	21-Jul	3-Aug	19-Aug	2-Sep	16-Sep	29-Sep	14-Oct		28-Oct				25-Nov		
		26	57	132											
		41	61	160											
		22	63	138											
Average		**30**	**60**	**143**	**295**	**273**	**436**		**471**				**525**		
Progressive		**386**	**1350**	**3358**	**7487**	**11029**	**17563**		**24154**				**38864**		
Hatch 2	17-Aug	31-Aug	16-Sep	29-Sep	14-Oct	28-Oct			25-Nov						
		38	107	160											
		45	118	168											
		43	112	160											
Average		**42**	**112**	**163**		**259**			**457**						
Progressive		**587**	**2380**	**4496**		**11995**			**24803**						
Hatch 3	16-Sep	29-Sep	14-Oct	28-Oct	11-Nov	24-Nov		16-Dec							7-Feb
		25	79	142											549
		25	103	190											527
		23	76	155											529
		23	91	182											489
		26	81	173											554
		26	79	155											
Average		**24**	**85**	**166**	**322**	**552**		**395**							**530**
Progressive		**318**	**1588**	**3916**	**8424**	**15603**		**24291**							**52365**
Hatch 4	14-Oct	28-Oct	11-Nov	25-Nov							7-Feb			28-Feb	
		41	116	162										524	
		45	120	156										500	
		44	116	166										465	
		42	135	160										515	
		35	108	154											
Average		**41**	**119**	**160**							**438**			**501**	
Progressive		**576**	**2240**	**4476**							**36858**			**47370**	
Hatch 5	11-Nov	25-Nov	9-Dec				7-Feb			28-Feb		14-Mar		28-Mar	
										480		488		484	
		31	103							418		546		505	
		30	85							449		523		505	
		29	85							513		412		498	
		51	123							496		552		249	
Average		**35**	**99**				**281**			**471**		**504**		**448**	
Progressive		**492**	**1876**				**18754**			**28648**		**35705**		**41980**	

Table 6.

Pen Average Feed Consumption of Emus Hatched July - November
23 - 44 Weeks of Age (grams/bird/day)

Weeks	23	24	25	26	27	28	29	31	32	35	36	38	40	42	44
Hatch 1							14-Feb		7-Mar	22-Mar		21-Apr		16-May	
							573		442	545		505		534	
							548		374	594		500		495	
							544		439	553		500		522	
							571		413	563		527		495	
							585		439	560		523		550	
Average							**564**		**421 c**	**563 b**		**511 d**		**519 c**	
Progressive							**84563**		**93412**	**101856**		**117183**		**130166**	
Hatch 2				14-Feb			7-Mar	22-Mar		21-Apr			16-May	14-Jun	
				546			421	506		506			421	594	
				501			437	499		527			437	587	
				541			446	528		535			446	624	
				590			445	520		542			445	657	
				579			465	513		521			465	510	
Average				**551**			**443**	**513 b**		**526 b**			**443 e**	**595 c**	
Progressive				**69467**			**78765**	**86463**		**102240**			**113309**	**130549**	
Hatch 3	28-Feb		14-Mar		28-Mar			21-Apr		16-May		14-Jun		11-Jul	
	512		512		497			471		545		620		667	
	531		502		522			642		518		595		665	
	514		587		525			477		532		609		638	
	540		549		497			638		517		599		658	
	683		581		624			495		593		605		786	
Average	**556**		**546**		**533**			**545 b**		**541 b**		**605 c**		**683 c**	
Progressive	**64045**		**71689**		**79151**			**92225**		**104418**		121976		**140410**	
Hatch 4	28-Mar		11-Apr			2-May			30-May		27-Jun		25-Jul	7-Aug	
	537		602			582			459		665		628	800	
	504		508			505			470		663		680	1135	
	512		532			547			449		714		672	857	
	475		515			526			452		633		657	991	
														829	
Average	**507**		**539**			**540**			**458 c**		**669 a**		**659 b**	**922 a**	
Progressive	**62052**		**69601**			**80941**			**93750**		**112480**		**130935**	**142924**	
Hatch 5		2-May				30-May			27-Jun		25-Jul	7-Aug		5-Sep	18-Sep
		513				472			673		670	694		858	1094
		503				494			585		642	743		792	1155
		520				471			591		619	625		860	1100
		983				480			592		648	764		936	1259
		1464				462			606		582	796		787	1277
Average		**797**				**476**			**609 a**		**632 a**	**724 a**		**847 b**	**1177**
Progressive		**66147**				**79469**			**96528**		**114236**	**123651**		**148201**	**163503**
SE									**46**		**27**	**34**		**51**	
LSD (p<0.05)									**61**		**36**	**45**		**71**	

Treatment averages in columns followed by a common letter are not significantly different (p>0.05)

Table 7. **Pen Average Feed Consumption of Emus Hatched July - November**

46 - 69 Weeks of Age (grams/bird/day)

Weeks	**46**	**48**	**50**	**52**	**54**	**56**	**58**	**60**	**61**	**62**	**64**	**65**	**66**	**68**	**69**
Hatch 1	14-Jun		11-Jul		7-Aug		5-Sep	18-Sep		5-Oct	18-Oct		31-Oct	14-Nov	21-Nov
	592		702		772		780	1197		963	834		832		
	545		756		905		951	1292		1301	1078		1062		
	601		689		856		943	1038		757	645		688		
	637		585		815		1141	1108		1318	1245		1112		
	650		778		876		844	944		964	668		626	659	494
Average	**605 c**		**702 c**		**845 b**		**932 a**	**1116 a**		**1060 a**	**894 a**		**864 a**	**659**	**494**
Progressive	**147718**		**166677**		**189491**		**216512**	**231016**		**249042**	**260663**		**271895**	**281118**	**284573**
Hatch 2	11-Jul		7-Aug		5-Sep	18-Sep	5-Oct	18-Oct		31-Oct	14-Nov	21-Nov			
	722		786		962	1069	851	703		701					
	749		782		1146	1290	1103	1037		1265					
	712		749		1025	913	911	710		650					
	796		905		1259	1175	686	1160		849					
	651		815		892	1300	1073	887		730	761	340			
Average	**726 b**		**807 bc**		**1057 a**	**1149 a**	**925 a**	**899 b**		**839 b**	**761**	**340**			
Progressive	**150148**		**171945**		**202587**	**217529**	**233248**	**244939**		**255846**	**266501**	**268879**			
Hatch 3	7-Aug		5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	21-Nov						
	815		852	1092	1006	791	679	714	336						
	815		996	1316	1359	1195	971	1129	691						
	815		994	1041	1025	851	704	756	604						
	823		1008	1205	771	1037	1059	1246	1255						
	815		854	1085	843	531	588	549	521						
Average	**816 b**		**941 a**	**1148 a**	**1001 ab**	**881 b**	**800 a**	**879 b**	**682**						
Progressive	**162454**		**189741**	**204662**	**221674**	**233123**	**243524**	**255824**	**260595**						
Hatch 4	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	28-Nov	12-Dec		27-Dec	9-Jan		23-Jan		
	786	1010	936	788	858	1010	382	504		511	496		581		
	1161	1254	868	957	1161	1012	757	700		610	610		729		
	1067	899	772	705	1067	603	708	584		385	385		507		
	1164	1315	659	668	1164	1270	821	780		504	504		735		
	1021	865	781	625	1021	509	735	645		460	460		510		
Average	**1040 a**	**1069**	**803 bc**	**749 b**	**1054 a**	**881 b**	**681 b**	**643 c**		**494 c**	**491 b**		**612 b**		
Progressive	**173072**	**186965**	**200617**	**210351**	**224055**	**236386**	**245914**	**254912**		**262320**	**268701**		**277275**		
Hatch 5	5-Oct	18-Oct	31-Oct	14-Nov	28-Nov	12-Dec	27-Dec	9-Jan		23-Jan					
	983	812	534	1094	624	741	616	404		458					
	1307	1113	1031	1155	1128	694	508	485		600					
	964	799	740	1100	764	686	682	505		579					
	1472	1244	1115	1259	1164	734	942	692		793					
	976	979	867	1277	737	647	239	329		663					
Average	**1140 a**	**990**	**85 ab**	**1177 a**	**883 ab**	**700 b**	**597 b**	**483 d**		**619 c**					
Progressive	**182891**	**195755**	**206901**	**223380**	**235748**	**245552**	**254509**	**260788**		**269448**					
SE	**77**		**97**	**98**	**149**	**138**	**166**	**88**		**136**	**104**		**60**		
LSD (p<0.05)	**108**		**136**	**152**	**210**	**201**	**234**	**125**		**199**	**183**		**105**		

Treatment averages in columns followed by a common letter are not significantly different (p>0.05)

Table 8. **Pen Average Daily Gain of Emus Hatched July - November**

0 - 20 Weeks of Age (grams /bird/day)

Weeks	**0**	**2**	**4**	**6**	**8**	**10**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Hatch 1	21-Jul	3-Aug	19-Aug	2-Sep	16-Sep	29-Sep	14-Oct		28-Oct				25-Nov		
		16	29	38	133	116	133		165				160		
		21	38	35	146	115	139		150				154		
		15	31	46	126	109	141		148				157		
Average		**17**	**33**	**40**	**135**	**113**	**138**		**154**				**157**		
Hatch 2															
	17-Aug	31-Aug	16-Sep	29-Sep	14-Oct	28-Oct	25-Nov								
		24	54	39											
		26	59	39											
		23	57	37											
Average		**24**	**57**	**38**		**131**	**150**								
Hatch 3															
	16-Sep	29-Sep	14-Oct	28-Oct	11-Nov	24-Nov		16-Dec							7-Feb
		12	28	72	109	182		97							152
		12	41	68	110	189		112							139
		11	33	61	104	174		92							170
		11	33	79	96	185		104							138
		14	33	79	100	208		99							143
		14	33	79	104	190		100							
Average		**12**	**33**	**73**	**104**	**188**		**101**							**148**
Hatch 4															
	14-Oct	28-Oct	11-Nov	25-Nov							7-Feb			28-Feb	
		20	46	58							121			147	
		22	51	62							131			143	
		18	49	65							141			142	
		17	48	62							128			139	
		16	44	61							133				
Average		**19**	**47**	**61**							**131**			**142**	
Hatch 5															
	11-Nov	25-Nov	9-Dec				7-Feb			28-Feb		14-Mar		28-Mar	
												193		89	
		15	41									191		70	
		14	39									141		89	
		12	41									127		118	
		22	49									182		116	
average		**16**	**42**				**87**			**177**		**167**		**97**	

Table 9. **Pen Average Daily Gain of Emus Hatched July - November**

23 - 44 Weeks of Age (grams /bird/day)

Age	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**31**	**32**	**35**	**36**	**38**	**40**	**42**	**44**
Weeks							14-Feb		7-Mar	22-Mar		21-Apr		16-May	
Hatch 1							115		56	104		65		52	
							119		44	98		63		50	
							122		68	73		60		62	
							120		57	96		63		56	
							123		76	60		58		55	
							120		**60 d**	**86 b**		**62**		**55 b**	
Average															
Hatch 2				14-Feb			7-Mar	22-Mar		21-Apr			16-May	14-Jun	
				139			85	83		78			48	78	
				131			83	79		78			71	68	
				135			90	90		78			48	61	
				143			81	94		77			64	78	
				148			79	81		75			57	70	
				139			**84**	**86 c**		**77 bc**			**58**	**71 b**	
Average															
Hatch 3	28-Feb		14-Mar		28-Mar			21-Apr		16-May		14-Jun		11-Jul	
	110		202		-35			89		79		96		81	
	102		170		-10			96		68		85		83	
	116		196		-2			105		58		53		89	
	121		155		0			97		43		75		105	
	123		184		-30			120		56		102		94	
	115		**181**		**-15**			**101 b**		**61 c**		**82**		**91 b**	
Average															
Hatch 4	28-Mar		11-Apr			2-May			30-May		27-Jun		25-Jul	7-Aug	
	63		122			90			49		141		73	185	
	33		107			81			59		100		92	142	
	69		118			86			45		138		79	149	
	37		107			90			30		117		87	118	
														137	
	51		**113**			**87**			**46 d**		**124 a**		**83**	**146 a**	
Average															
Hatch 5		2-May				30-May			27-Jun		25-Jul	7-Aug		5-Sep	18-Sep
		108				87			138		123	26		107	232
		87				83			119		106	138		96	125
		100				92			108		87	52		214	206
		114				46			144		101	55		139	125
		125				59			143		55	111		122	172
		107				**74**			**130 a**		**94 b**	**77**		**136 a**	**172**
SE									**16**		**18**	**24**		**29**	
LSD (p<0.05)									**12**		**23**	**ns**		**40**	

Treatment averages in columns followed by a common letter are not significantly different (p>0.05)

Table 10.

Pen Average Daily Gain of Emus hatched July - November
46 - 69 Weeks of Age (grams /bird/day)

Weeks	46	48	50	52	54	56	58	60	61	62	64	65	66	68	69
Hatch 1	14-Jun		11-Jul		7-Aug		5-Sep	18-Sep		5-Oct	18-Oct		31-Oct	14-Nov	21-Nov
	90		79		67		96	172		101	67		113		
	67		64		59		111	153		94	78		110		
	76		21		107		128	152		66	2		129		
	100		-8		45		149	91		199	50		95		
	83		82		125		90	66		73	1		90	28	32
Average	**83 c**		**47**		**81 b**		**115 a**	**127 a**		**107 a**	**39**		**107 a**	**28**	**32**
Hatch 2															
	11-Jul		7-Aug		5-Sep	18-Sep	5-Oct	18-Oct		31-Oct	14-Nov	21-Nov			
	54		123		144	150	142	15		124					
	97		56		147	110	60	73		172					
	116		62		205	85	101	73		73					
	68		77		181	90	118	68		62					
	87		80		152	168	158	62		107	95	-1			
Average	**85 c**		**79**		**166 a**	**121 a**	**116 a**	**58 b**		**107 a**	**95**	**-1**			
Hatch 3															
	7-Aug		5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	21-Nov						
	147		116	214	150	58	90	84	-119						
	85		110	164	156	85	85	82	51						
	116		155	166	145	85	55	127	89						
	113		116	82	15	92	146	162	93						
	115		137	147	102	-28	75	26	96						
Average	**115 b**		**127**	**154 a**	**114 ab**	**58 b**	**90 ab**	**96 ab**	**42**						
Hatch 4															
	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	28-Nov	12-Dec		27-Dec	9-Jan		23-Jan		
	104	196	105	68	147	196	-20	-10		52	62		58		
	92	134	127	78	92	59	-139	257		21	21		38		
	171	98	88	84	171	68	52	18		-33	-13		27		
	139	170	-156	6	139	83	91	50		18	18		40		
	123	134	65	40	123	-2	59	67		21	21		53		
Average	**126 ab**	**146**	**46**	**55 b**	**134 ab**	**81 ab**	**9 b**	**76ab**		**16 b**	**22**		**43 b**		
Hatch 5															
	5-Oct	18-Oct	31-Oct	14-Nov	28-Nov	12-Dec	27-Dec	9-Jan		23-Jan					
	154	73	107	232	65	94	33	0		-10					
	183	64	110	125	102	4	-49	0		20					
	130	52	125	206	111	19	95	0		47					
	205	127	162	125	78	24	61	0		68					
	142	167	195	172	38	20	-66	0		56					
average	**163 a**	**96**	**140**	**172 a**	**79 b**	**32 b**	**15 b**	**0 b**		**36 b**					
SE	**28**		**70**	**36**	**40**	**42**	**66**	**55**		**50**	**36**		**14**		
LSD (p<0.05)	**39**		**ns**	**55**	**56**	**61**	**93**	**77**		**73**	**ns**		**24**		

Treatment averages in columns followed by a common letter are not significantly different (p>0.05)

Table 11.

Pen Average Live Weight of Emus Hatched July - November
February to July (grams)

Hatch 1	7-Feb	14-Feb	28-Feb	7-Mar	14-Mar	22-Mar	28-Mar	11-Apr	21-Apr	2-May	16-May	30-May	14-Jun	27-Jun	11-Jul
		23307		24493		26057			28007		29315		31930		34309
		22993		24038		25217			27264		28512		31644		32200
		23800		25236		26336			27900		29450		30467		32189
		23157		24350		25793			27671		29079		31967		31744
		23636		25229		26129			27879		29408		31740		33944
Average		**23379**		**24669**		**25906**			**27744**		**29153**		**31550**		**32877**
Hatch 2		14-Feb		7-Mar		22-Mar			21-Apr		16-May		14-Jun		11-Jul
		21450		23233		24483			26825		28033		30283		31744
		20291		22027		23218			25564		27327		29300		32818
		21133		23033		24383			26708		27900		29683		31920
		21692		23392		24808			27117		28717		30967		32800
		20958		22608		23817			26075		27475		29500		31860
Average		**21105**		**22859**		**24142**			**26458**		**27890**		**29947**		**32229**
Hatch 3	7-Feb		28-Feb		14-Mar		28-Mar		21-Apr		16-May		14-Jun		11-Jul
	16069		18385		21212		20317		22447		24429		27200		29400
	16008		18146		20522		20389		22700		24400		26856		29100
	16692		19138		21885		21862		24392		25854		27392		29800
	15531		18069		20238		20242		22562		23631		25808		28654
	16013		18600		21175		20713		23625		25014		27975		30513
Average	**16063**		**18468**		**21006**		**20705**		**23145**		**24666**		**27046**		**29493**
Hatch 4	7-Feb		28-Feb		14-Mar		28-Mar	11-Apr		2-May		30-May		27-Jun	
	11142		14727		17133		18020	19729		21613		22973		26920	
	11964		14546		16708		17169	18662		20354		22008		24800	
	12718		15538		18008		18977	20631		22385		23654		27523	
	11617		14685		16892		17415	18915		20815		21662		24931	
	11938														
Average	**11876**		**14874**		**17185**		**17895**	**19484**		**21292**		**22574**		**26043**	
Hatch 5	7-Feb		28-Feb		14-Mar		28-Mar	11-Apr		2-May		30-May		27-Jun	
	6927		10467		13167		14417	16175		18433		20875		24733	
	6293		9325		12000		12975	14713		16538		18867		22186	
	6350		10043		12023		13275	14946		17038		19608		22638	
	5907		10044		11817		13473	15100		17500		18800		22845	
			10567		13118		14745	16230		18860		20517		24527	
Average	**6369**		**10089**		**12425**		**13777**	**15433**		**17674**		**19733**		**23386**	

Table 12. **Pen Average Live Weight of Emus Hatched July - November**

July - January (grams)

Hatch 1	**25-Jul**	**7-Aug**	**5-Sep**	**18-Sep**	**5-Oct**	**18-Oct**	**31-Oct**	**14-Nov**	**21-Nov**	**28-Nov**	**12-Dec**	**27-Dec**	**9-Jan**	**23-Jan**
		36109	39073	41364	43073	43945	45410							
		35078	38800	40775	41900	41925	43600							
		33789	37000	38989	40589	41600	43033							
		32956	37278	38467	41856	42500	43730							
		37322	39944	40800	42044	42056	43222	43611	43833					
Average		**35050 a**	**38418 b**	**40078 a**	**41892 a**	**42405 a**	**43799 a**	**43611**	**43833**					
Hatch 2		7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	21-Nov					
		35056	39222	41178	43590	43790	45400							
		34490	40436	41545	43270	44220	45170							
		33420	37670	39100	40113	41313	43550							
		34888	40138	40767	42767	43644	44444							
		34020	38289	40467	43144	43944	45333	46667	46578					
Average		**34374 b**	**39150 a**	**40611 a**	**42576 a**	**43382 a**	**44779 a**	**46667**	**46578**					
Hatch 3		7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	21-Nov					
		33356	36732	39510	42060	42810	43580	44750	43920					
		32940	37430	39590	42060	43160	43870	45650	43270					
		31560	34760	36890	39540	40650	41760	42910	46270					
		31711	35088	36150	36413	37613	39513	41775	42425					
		33620	37590	39500	41240	40870	41840	42200	42870					
Average		**32637 c**	**36319 c**	**38328 b**	**40262 b**	**41020 b**	**42112 b**	**43457 a**	**43751**					
Hatch 4	25-Jul	7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov		28-Nov	12-Dec	27-Dec	9-Jan	23-Jan
	28960	29170	32170	34720	36510	37390	39300	39350		39075	38938	39713	40575	41388
	27369	28820	34180	36400	38070	39210	40300	40600		41450	42180	42450	41988	42363
	29746	29870	32940	34130	36400	38056	39067	40822		41644	39700	43550	43838	44375
	27408	29970	33400	35210	38100	36075	36150	38488		39650	40925	41671	41929	42486
		30090	34060	35660	37930	38780	39300	40200		40170	41000	42000	42300	43038
Average	**28371**	**29584 d**	**33350 d**	**35224 c**	**37402 d**	**37902 c**	**38823 c**	**39891 b**		**40398**	**40549**	**41877**	**42126**	**42730**
Hatch 5	25-Jul	7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov		28-Nov	12-Dec	27-Dec	9-Jan	23-Jan
	28167	28508	31611	34460	37080	38030	38530	39920		40830	42140	42638	42600	42463
	25157	26957	29730	31360	36860	37530	38980	40600		42160	42430	43850	43838	44500
	25085	25762	31970	34650	34470	35300	37100	38530		39950	40010	39275	39013	39288
	25673	26391	30420	32040	35520	37170	38130	40240		41330	41670	42588	42838	43788
	26055	27500	31050	33290	35700	37870	39100	41640		42170	42450	41463	41300	42088
Average	**26027**	**27023 e**	**30956 e**	**33160 d**	**35926 d**	**37180 c**	**38368 c**	**40186 b**		**41288**	**41740**	**41963**	**41918**	**42425**
SE		**840**	**811**	**655**	**1301**	**1317**	**1049**	**965**		**1177**	**1463**	**1729**	**1562**	**1374**
LSD (P<0.05)		**1184**	**1143**	**923**	**1833**	**1856**	**1479**	**1493**		**ns**	**ns**	**ns**	**ns**	**ns**

Treatment averages in columns followed by a common letter are not significantly different (p>0.05)

Table 13. **Pen Average Feed Consumption of Emus Hatched July - November**
February - July (grams/bird/day)

Hatch 1	**14-Feb**		**7-Mar**		**22-Mar**			**21-Apr**	**16-May**		**14-Jun**		**11-Jul**	
	573		442		545			505	534		592		702	
	548		374		594			500	495		545		756	
	544		439		553			500	522		601		689	
	571		413		563			527	495		637		585	
	585		439		560			523	550		650		778	
Average	**564a**		**421c**		**563**			**511**	**519 a**		**605 b**		**702**	
Progressive	***84563***		***93412***		***101856***			***117183***	***130166***		***147718***		***166677***	
Hatch 2	14-Feb		7-Mar		22-Mar			21-Apr	16-May		14-Jun		11-Jul	
	546		421		506			506	421		594		722	
	501		437		499			527	437		587		749	
	541		446		528			535	446		624		712	
	590		445		520			542	445		657		796	
	579		465		513			521	465		510		651	
Average	**551 a**		**442 bc**		**513**			**526**	**442 c**		**594 b**		**726**	
Progressive	***69467***		***78765***		***86463***			***102240***	***113309***		***130549***		***150148***	
Hatch 3		28-Feb		14-Mar		28-Mar		21-Apr	16-May		14-Jun		11-Jul	
		512		512		497		471	545		620		667	
		531		502		522		642	518		595		665	
		514		587		525		477	532		609		638	
		540		549		497		638	517		599		658	
		683		581		624		495	593		605		786	
Average		**556 a**		**546 a**		**533**		**545**	**540 a**		**605 b**		**683**	
Progressive		***64045***		***71689***		***79151***		***92225***	***104418***		***121976***		***140410***	
Hatch 4		28-Feb		14-Mar		28-Mar	11-Apr			30-May		27-Jun		25-Jul
		524		515		537	602			459		665		628
		500		523		504	508			470		663		680
		465		591		512	532			449		714		672
		515		537		475	515			452		633		657
Average		**500 b**		**541 a**		**507**	**539**			**457 bc**		**668 a**		**659**
Progressive		***47370***		***54952***		***62052***	***69601***			***93750***		***112480***		***130935***
Hatch 5		28-Feb		14-Mar		28-Mar	11-Apr			30-May		27-Jun		25-Jul
		480		488		484	515			472		673		670
		418		546		505	719			494		585		642
		449		523		505	557			471		591		619
		513		412		498	542			480		592		648
		496		552		249	323			462		606		582
Average		**471 c**		**504 a**		**448**	**531**			**475 b**		**609 b**		**632**
Progressive		***28648***		***35705***		***41980***	***49414***			***79469***		***96528***		***114236***
SE		**30**		**38**		**59**	**79**			**21**		**38**		**53**
LSD (P<0.05)		**39**		**50**		**ns**	**ns**			**27**		**51**		**ns**

Treatment averages in columns followed by a common letter are not significantly different (p>0.05)

Table 14. **Pen Average Feed Consumption of Emus Hatched July - November**

August to January (grams/bird/day)

Hatch 1	**7-Aug**	**5-Sep**	**18-Sep**	**5-Oct**	**18-Oct**	**31-Oct**	**14-Nov**	**21-Nov**	**28-Nov**	**12-Dec**	**27-Dec**	**9-Jan**	**23-Jan**
	772	780	1197	963	834	832							
	905	951	1292	1301	1078	1062							
	856	943	1038	757	645	688							
	815	1141	1108	1318	1245	1112							
	876	844	944	964	668	626	659	494					
Average	**844 a**	**932**	**1116**	**1060**	**893 ab**	**864 d**	**659**	**494**					
Progressive	***189491***	***216512***	***231016***	***249042***	***260663***	***271895***	***281118***	***284573***					
Hatch 2	7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	21-Nov					
	786	962	1069	851	703	701							
	782	1146	1290	1103	1037	1265							
	749	1025	913	911	710	650							
	905	1259	1175	686	1160	849							
	815	892	1300	1073	887	730	761	340					
Average	**807 bc**	**1057**	**1149**	**925**	**899 a**	**838 b**	**761**	**340**					
Progressive	***171945***	***202587***	***217529***	***233248***	***244939***	***255846***	***266501***	***268879***					
Hatch 3	7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	21-Nov					
	815	852	1092	1006	791	679	714	336					
	815	996	1316	1359	1195	971	1129	691					
	815	994	1041	1025	851	704	756	604					
	823	1008	1205	771	1037	1059	1246	1255					
	815	854	1085	843	531	588	549	521					
Average	**816 bc**	**941**	**1148**	**1001**	**880 ab**	**800 b**	**878b**	**682**					
Progressive	***162454***	***189741***	***204662***	***221674***	***233123***	***243524***	***255824***	***260595***					
Hatch 4	7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov		28-Nov	12-Dec	27-Dec	9-Jan	23-Jan
	800	786	1010	936	788	858	1010		382	504	511	496	581
	1135	1161	1254	868	957	1161	1012		757	700	610	610	729
	857	1067	899	772	705	1067	603		708	584	385	385	507
	991	1164	1315	659	668	1164	1270		821	780	504	504	735
	829	1021	865	781	625	1021	509		735	645	460	460	510
Average	**922 a**	**1040**	**1069**	**803**	**748 b**	**1054 a**	**880b**		**681**	**643**	**494**	**491**	**612**
Progressive	***142924***	***173072***	***186965***	***200617***	***210351***	***224055***	***236386***		***245914***	***254912***	***262320***	***268701***	***277275***
Hatch 5	7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov		28-Nov	12-Dec	27-Dec	9-Jan	23-Jan
	694	858	1094	983	812	534	1094		624	741	616	404	458
	743	792	1155	1307	1113	1031	1155		1128	694	508	485	600
	625	860	1100	964	799	740	1100		764	686	682	505	579
	764	936	1259	1472	1244	1115	1259		1164	734	942	692	793
	796	787	1277	976	979	867	1277		737	647	239	329	663
Average	**724 bc**	**847**	**1177**	**1140**	**989 a**	**857 b**	**1177a**		**883**	**700**	**597**	**483**	**619**
Progressive	***123651***	***148201***	***163503***	***182891***	***195755***	***206901***	***223380***		***235748***	***245552***	***254509***	***260788***	***269448***
SE	**78**	**122**	**83**	**182**	**104**	**123**	**147**		**208**	**47**	**166**	**98**	**85**
LSD (P<0.05)	**103**	**ns**	**ns**	**ns**	**146**	**173**	**227**		**ns**	**ns**	**ns**	**ns**	**ns**

Treatment averages in columns followed by a common letter are not significantly different (p>0.05)

Table 15. **Pen Average Daily Gain of Emus Hatched July - November**

February - July (grams/bird/day)

Hatch 1	**14-Feb**	**28-Feb**	**7-Mar**	**14-Mar**	**22-Mar**	**28-Mar**	**11-Apr**	**21-Apr**	**16-May**	**30-May**	**14-Jun**	**27-Jun**	**11-Jul**	**25-Jul**
	115		56		104			65	52		90		79	
	119		44		98			63	50		67		64	
	122		68		73			60	62		76		21	
	120		57		96			63	56		100		-8	
	123		76		60			58	55		83		82	
Average	**120 c**		**60 c**		**86 a**			**62 c**	**55 b**		**83 b**		**47 b**	
Hatch 2	14-Feb		7-Mar		22-Mar			21-Apr	16-May		14-Jun		11-Jul	
	139		85		83			78	48		78		54	
	131		83		79			78	71		68		97	
	135		90		90			78	48		61		116	
	143		81		94			77	64		78		68	
	148		79		81			75	57		70		87	
Average	**139 b**		**84 b**		**86 a**			**77 c**	**58 b**		**71 b**		**85 a**	
Hatch 3		28-Feb		14-Mar		28-Mar		21-Apr	16-May		14-Jun		11-Jul	
		110		202		-35		89	79		96		81	
		102		170		-10		96	68		85		83	
		116		196		-2		105	58		53		89	
		121		155		0		97	43		75		105	
		123		184		-30		120	56		102		94	
Average		**114 c**		**181 a**		**-15**		**101 b**	**61 ab**		**82 b**		**91 a**	
Hatch 4		28-Feb		14-Mar		28-Mar	11-Apr			30-May		27-Jun		25-Jul
		147		172		63	122			49		141		73
		143		154		33	107			59		100		92
		142		176		69	118			45		138		79
		139		158		37	107			30		117		87
Average		**142 c**		**165 a**		**51 b**	**113 a**			**46 b**		**124 a**		**83 a**
Hatch 5		28-Feb		14-Mar		28-Mar	11-Apr			30-May		27-Jun		25-Jul
				193		89	126			87		138		123
				191		70	124			83		119		106
				141		89	119			92		108		87
				127		118	116			46		144		101
				182		116	106			59		143		55
Average		**177 a**		**167 a**		**97 a**	**118 a**			**74 a**		**130 a**		**94 a**
SE		**7**		**18**		**17**	**7**			**13**		**15**		**25**
LSD (P<0.05)		**9**		**24**		**22**	**10**			**17**		**21**		**33**

Treatment averages in columns followed by a common letter are not significantly different (p>0.05)

Table 16.

Pen Average Daily Gain of Emus Hatched July - November
August - January (grams/bird/day)

Hatch 1	**7-Aug**	**5-Sep**	**18-Sep**	**5-Oct**	**18-Oct**	**31-Oct**	**14-Nov**	**21-Nov**	**28-Nov**	**12-Dec**	**27-Dec**	**9-Jan**	**23-Jan**
	67	96	172	101	67	113							
	59	111	153	94	78	110							
	107	128	152	66	2	129							
	45	149	91	199	50	95							
	125	90	66	73	1	90	28	32					
Average	**81 b**	**115**	**127**	**107**	**39**	**107**	**28**	**32**					
Hatch 2	7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	21-Nov					
	123	144	150	142	15	124							
	56	147	110	60	73	172							
	62	205	85	101	73	73							
	77	181	90	118	68	62							
	80	152	168	158	62	107	95	-1					
Average	**79 b**	**166**	**121**	**116**	**58**	**107**	**95**	**-1**					
Hatch 3	7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov	21-Nov					
	147	116	214	150	58	90	84	-119					
	85	110	164	156	85	85	82	51					
	116	155	166	145	85	55	127	89					
	113	116	82	15	92	146	162	93					
	115	137	147	102	-28	75	26	96					
Average	**115 a**	**127**	**154**	**114**	**58**	**90**	**96 b**	**42**					
Hatch 4	7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov		28-Nov	12-Dec	27-Dec	9-Jan	23-Jan
	185	104	196	105	68	147	196		-20	-10	52	62	58
	142	92	134	127	78	92	59		-139	257	21	21	38
	149	171	98	88	84	171	68		52	18	-33	-13	27
	118	139	170	-156	6	139	83		91	50	18	18	40
	137	123	134	65	40	123	-2		59	67	21	21	53
Average	**146 a**	**126**	**146**	**46**	**55**	**134**	**81 b**		**9**	**76**	**16**	**22**	**43**
Hatch 5	7-Aug	5-Sep	18-Sep	5-Oct	18-Oct	31-Oct	14-Nov		28-Nov	12-Dec	27-Dec	9-Jan	23-Jan
	26	107	232	154	73	107	232		65	94	33	0	-10
	138	96	125	183	64	110	125		102	4	-49	0	20
	52	214	206	130	52	125	206		111	19	95	0	47
	55	139	125	205	127	162	125		78	24	61	0	68
	111	122	172	142	167	195	172		38	20	-66	0	56
Average	**77 b**	**136**	**172**	**163**	**96**	**140**	**172 a**		**79**	**32**	**15**	**0**	**36**
SE	**32**	**38**	**38**	**77**	**31**	**36**	**47**		**94**	**79**	**54**	**26**	**29**
LSD (P<0.05)	**42**	**ns**	**ns**	**ns**	**ns**	**ns**	**72**		**ns**	**ns**	**ns**	**ns**	**ns**

Treatment averages in columns followed by a common letter are not significantly different (p>0.05)

Live weight

Diagrams 1 and 2 show average live weight of each hatch from hatch to 42 weeks of age and from 42 weeks of age to slaughter. Significant weight for age differences were recorded between hatches (Tables 3 & 4), with the later hatched birds being generally lighter from 20 to 30 weeks of age and heavier from 35 to 55 weeks of age (P <0.05). Beyond this age , with the exception of hatch 1, the earlier hatched birds became heavier and finished to heavier live weights.

Diagram 1.

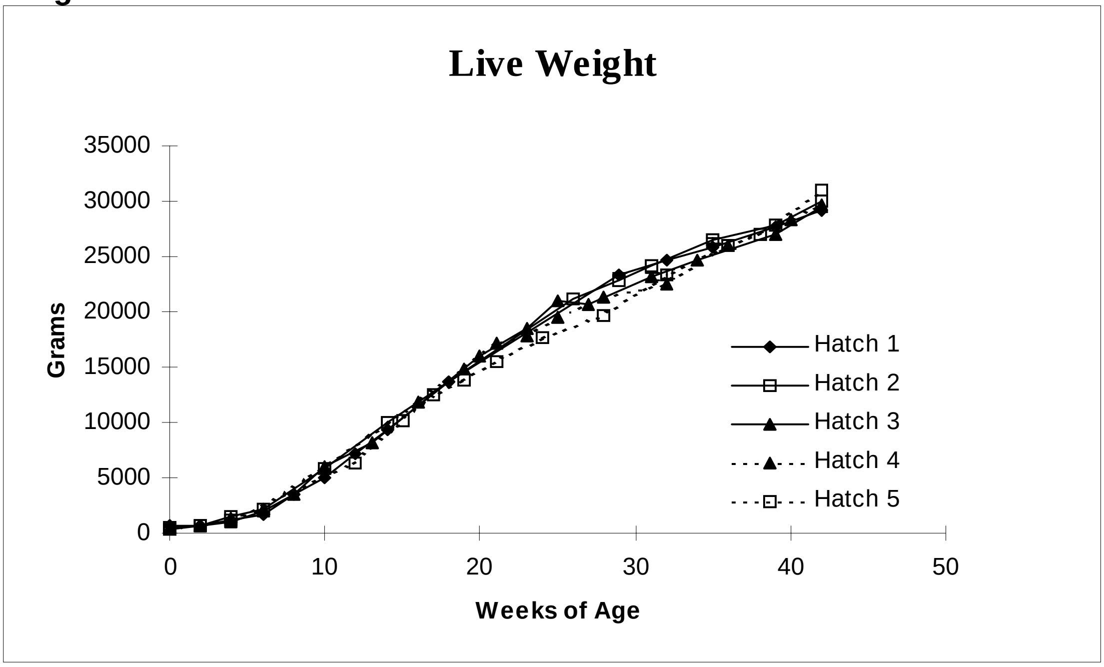
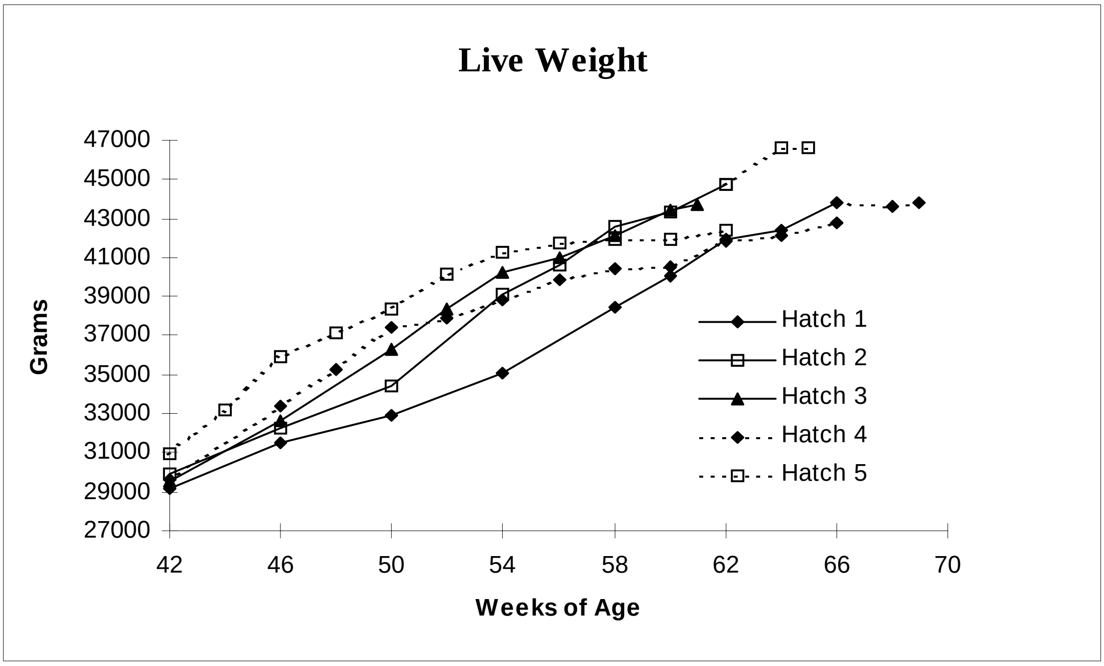


Diagram 2.



Although the small live weight differences between hatches up to 42 weeks of age were of no real commercial significance and direct age comparisons were not possible the low standard errors recorded over this period (158g - 435g) indicate that different growth models can be fitted for each hatch. Significant differences ($P<0.05$) were measured at 31 weeks of age when hatches 1 & 2 were 7 percent heavier than hatches 4 and 5.

Diagram 3 **Gain – Age**

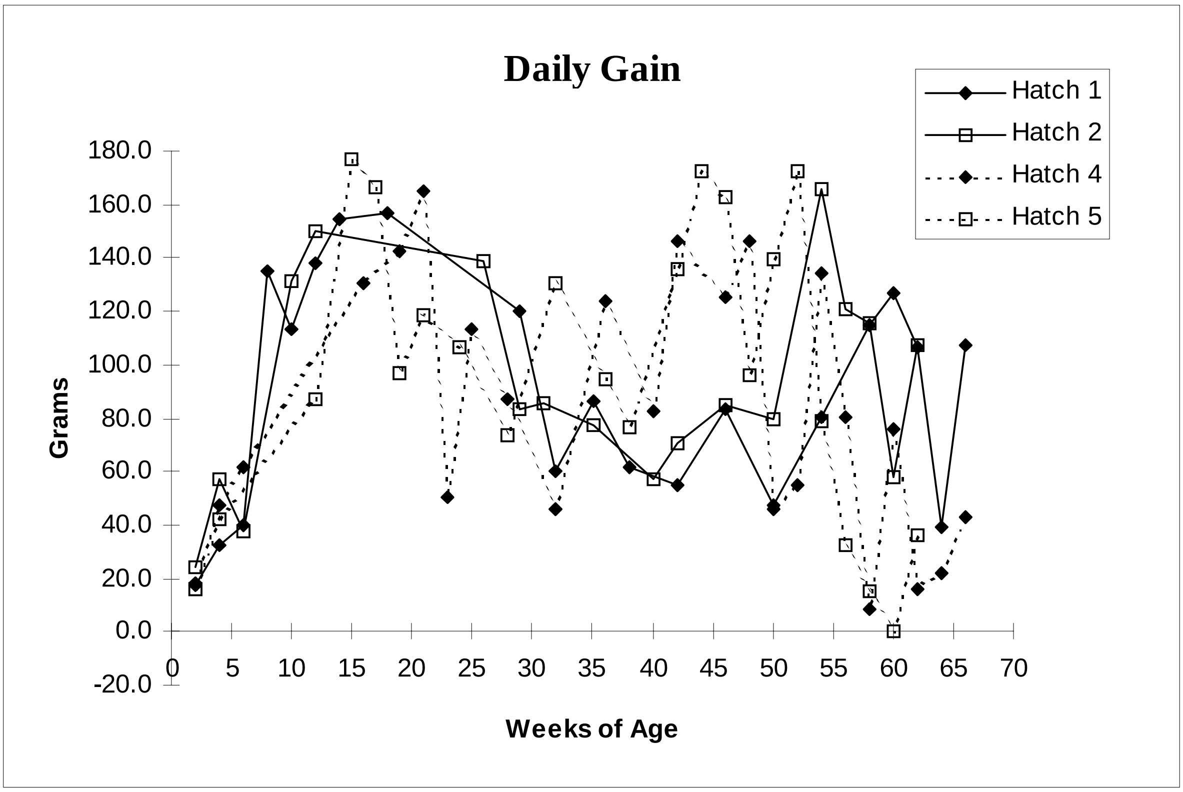
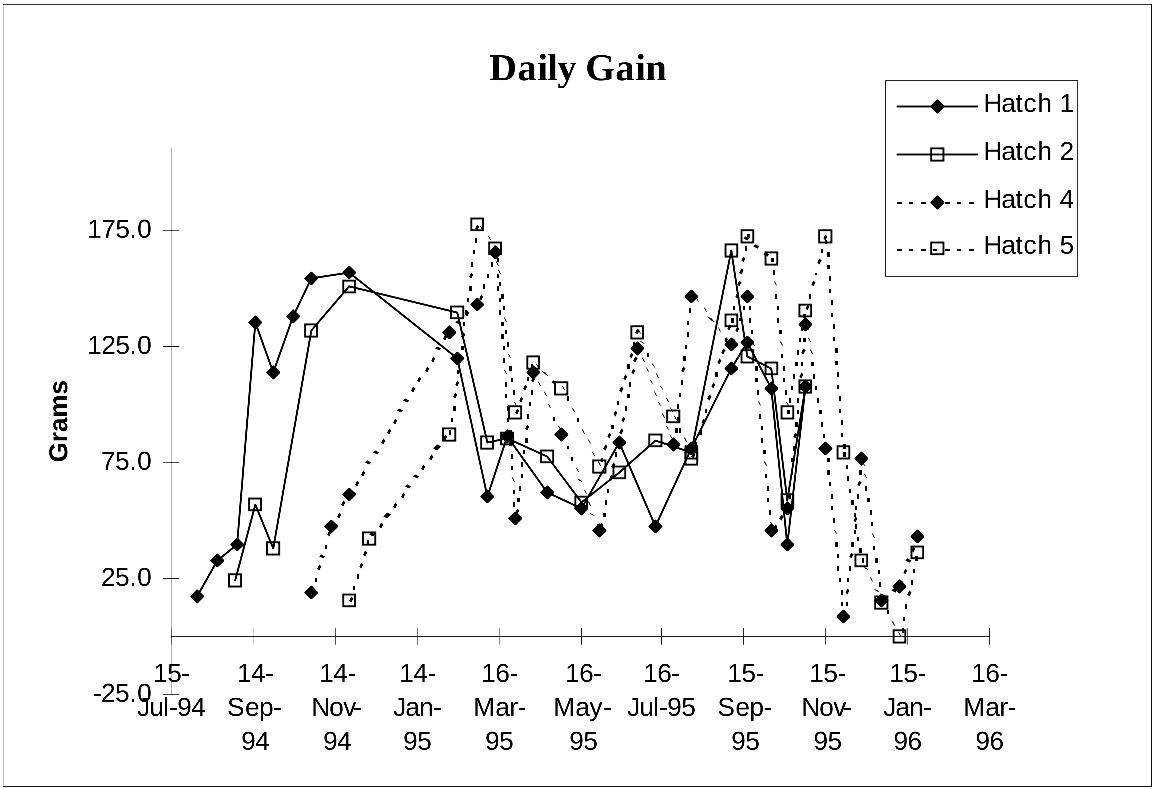


Diagram 4. **Gain – Season**



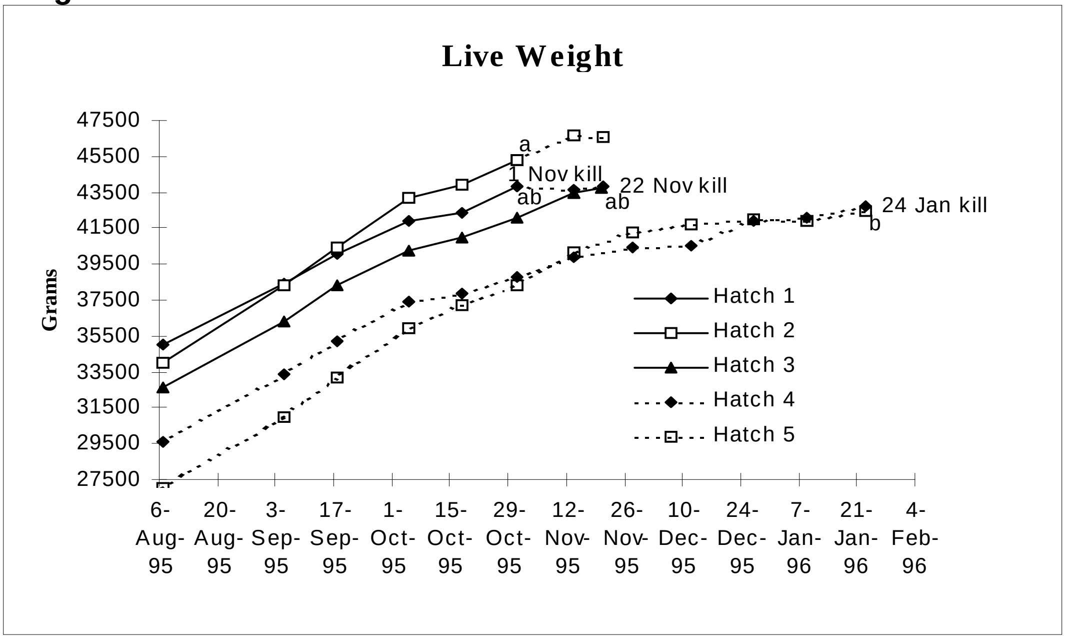
Diagrams 3 & 4 show that the weight for age differences recorded between hatches can be explained by season impacting on the birds appetite and growth.
Early hatched birds gained weight rapidly until autumn when growth slowed at 25 to 35 weeks of age. Low levels of growth were recorded throughout the winter months until late spring stimulated appetite and growth at 50 - 55 weeks of age. Maximum live weight was reached in mid November at 65 - 70 weeks of age.

Late hatched birds initially grew at a similar rate to the early hatched birds but growth slowed as they approached autumn at the younger ages of 10 - 15 weeks. Throughout winter they maintained higher rates of gain than the earlier hatched birds and responded to the stimulus of spring earlier when 30 -35 weeks of age. They reached a lower maximum live weight in mid December at 50 - 55 weeks of age.

Seasonal Plateau of Live Weight

Season caused all hatches to reach a peak live weight prior to December 12 (Diagram 5.) with earlier hatched flocks reaching higher live weights than later hatches.

Diagram 5.



Feed Consumption

Diagram 6.

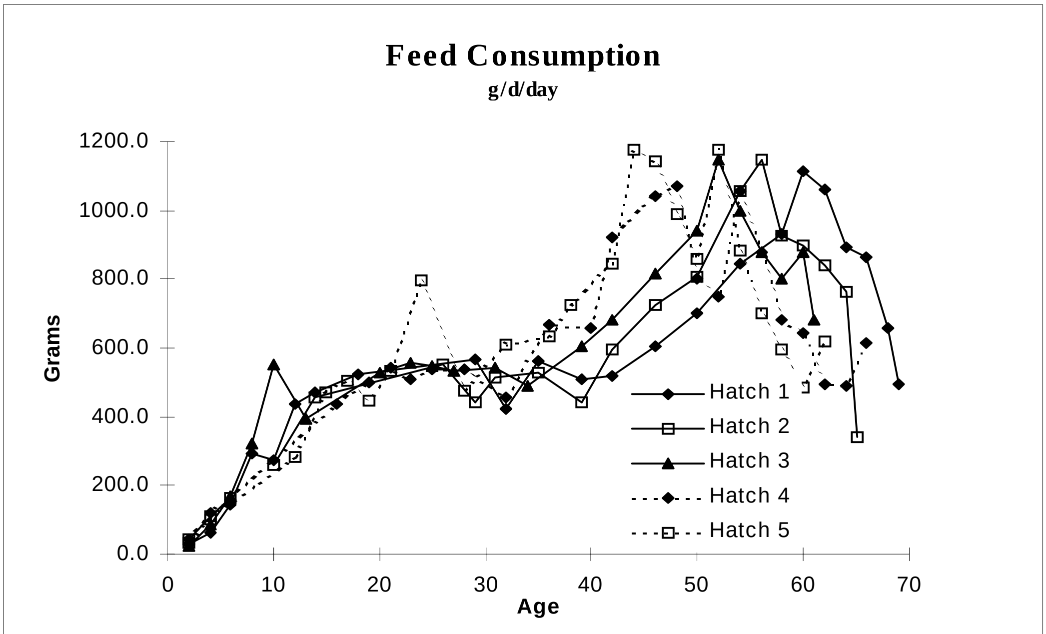


Diagram 6 and 7 show that while season stimulated the appetite of later hatched birds at a younger age feed consumption of all hatches peaked in August - September and all hatches ate similar amounts. Although significant differences were recorded between hatches on most weigh days (Tables 12 & 13) this was not consistent for any particular hatch. This inconsistency was considered to be caused by aggression between birds in the 20 X 40 metre pens interrupting normal feeding patterns, causing it to fluctuate.

Diagram 7.

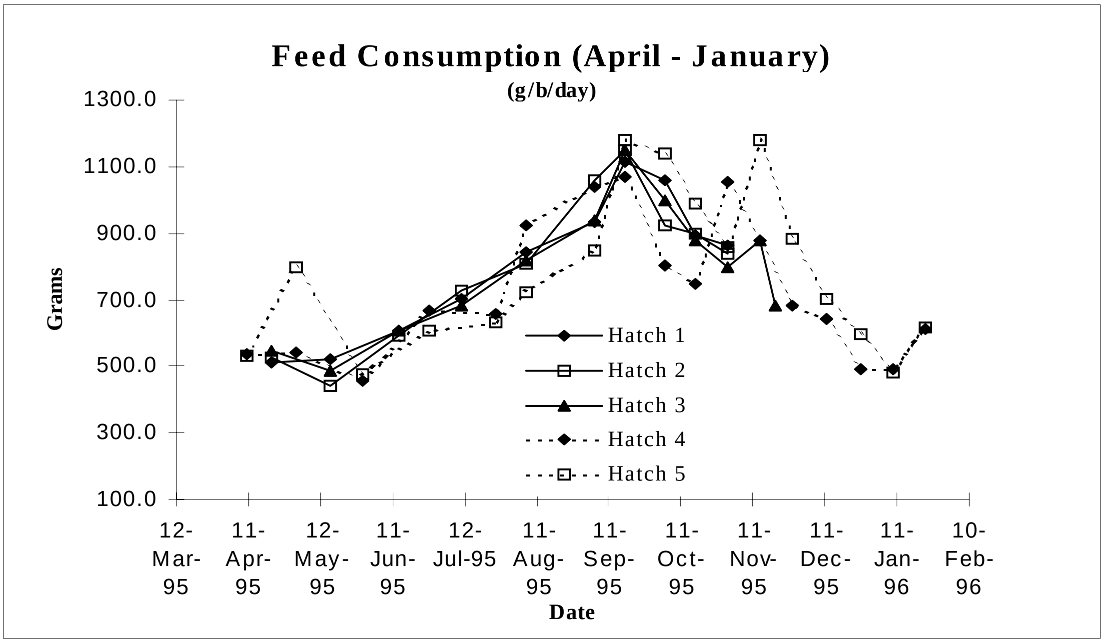
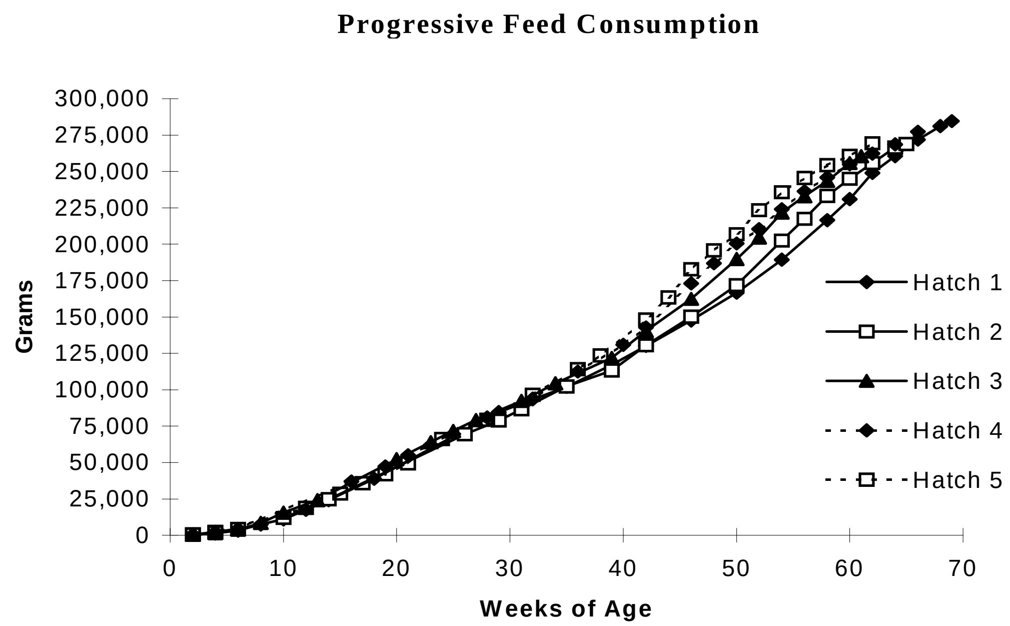


Diagram 8.



The progressive feed consumption (Tables 5-7)for each hatch was similar until later hatched flocks showed a seasonal increase in appetite at a correspondingly younger age. Consumption over the total growing period, with the exception of Hatch 1, was similar for all hatches.

Table 16 shows that at 32 weeks of age the total amount of feed eaten was similar for all hatches. Season then impacted on the late hatched birds and stimulated appetite causing the amount of food they ate by 42 weeks of age to be greater than the amount eaten by the earlier hatched birds which had reached 42 weeks of age prior to the shortest day on 22 June. Over the total growth period to slaughter hatches 1 and 4 ate more feed than hatches 2 and 3 (Table 16).

Table 16.

Feed Eaten
kg/bird

	0 - 32 weeks	0 - 42 weeks	42w - Slghter	Total
Hatch 1	93	130**c**	144**a**	274**a**
Hatch 2	91	130**c**	128**bc**	258**b**
Hatch 3	93	140**b**	120**c**	260**b**
Hatch 4	94	143**ab**	134**b**	277**a**
Hatch 5	96**ns**	148**a***	121**c**	269**ab**
SE	4.1	4.6	5.7	8.6

* Values in columns followed by a common letter are not significantly different (p>0.05)

However, considering that hatches 1, 2 and 3 were slaughtered close to peak fatness and hatches 4 and 5 should have been slaughtered earlier as they reached peak fatness on 12 December, saving up to 20 kilograms of feed per bird, all hatches, except hatch 1, would have had a total feed consumption of about 260 kilograms. Hatch 1 failed to finish at an earlier date, was 4 weeks older at slaughter and incurred a substantial feed penalty.

Finisher Ration

When the experimental data was analysed on the basis of bird age and period of feeding, finisher ration had no effect on live weight, feed consumed and live weight gain. However, analysis on the basis of season (date) showed significant differences for most parameters and showed that season overrode any effect age and period of feeding had on finisher ration consumption and gain during the finishing phase.

Liveweight

Across hatches (Table 17.) birds fed the higher energy diets were consistently heavier from 7 August through to 31 October. Birds fed the high energy/low protein ration grew similarly to those fed the high energy ration with recommended levels of protein.

Table 17.

Live Weight* grams

	7 Aug	5 Sept	5 Oct	31 Oct	14 Nov	23 Jan
High Energy 1	34562 **a**	36175 **a**	40260 **a**	42239 **a**	41451	41357
Low Energy 2	33027 **b**	34866 **b**	38914 **b**	40860 **b**	40924	44000
HE/LP 3	34941 **a**	36114 **a**	39711 **b**	41684 **b**	41142	42175
SE	531	815	836	1073	1011	1231
LSD (p<0.05)	795	835	857	1100	NS	NS

Values in columns followed by a common letter are not significantly different (p>0.05)
*Ration treatment averages adjusted using live weight at commencement of feeding as a covariate.
HE/LP High Energy Low Protein
SE Standard Error
NS differences not significant (p>0.05)

Consumption

Birds ate less of the higher energy diets (Table 18.). They did not however, fully compensate for the higher energy content of the high energy diets and ate about 10 percent more energy until October (Table 19.) . After this date the birds fully compensated for dietary energy level and treatments generally consumed similar amounts of energy.

Table 18.

Feed Consumption
(grams/bird/day)

	7 Aug	5 Sept	5 Oct	31 Oct	14 Nov	23 Jan
High Energy 1	799	913 **b**	917	745 **b**	879 **b**	531
Low Energy 2	841	1055 **a**	1084	1079 **a**	881 **b**	714
HE/LP 3	835	879 **b**	927	766 **b**	1177 **a**	586
SE	52	100	182	123	147	85
LSD (p<0.05)	NS	99	NS	122	254	NS

Values in columns followed by a common letter are not significantly different (p>0.05)
HE/LP High Energy Low Protein
SE Standard Error
NS differences not significant (p>0.05)

Table 19.

Calculated Energy Intake
(mJ/bird/day)

	7 Aug	5 Sept	5 Oct	31 Oct	14 Nov*	23 Jan
High Energy 1	10.6	12.1	12.2	9.9	11.7	7.0
Low Energy 2	8.8	11.0	11.3	11.3	9.2	7.5
HE/LP 3	11.1	11.7	12.3	10.2	15.6	7.8

HE/LP High Energy Low Protein
* Average of hatches 3,4 &5.

Slaughter

Table 20.

Carcase Weight
(Kg)

	Ration 1 H Energy	Ration 2 L Energy	Ration 3 HE/LP	Hatch Average
Hatch 1	21.4	20.7	20.3	20.9 **a**
Hatch 2	20.5	21.2	21.4	21.0 **a**
Hatch 3	21.0	21.1	20.3	20.9 **a**
Hatch 4	20.2	20.1	20.0	20.1 **b**
Hatch 5	20.4	19.9	20.7	20.3 **b**
Ration Average	20.7	20.6	20.5	

Values in columns followed by a common letter are not significantly different ($p>0.05$)
H high, L low, HE/LP High Energy Low Protein
NS ($p>0.05$)

Carcases produced from hatches 1 - 3 were heavier than carcases from hatches 4 and 5. Across hatches finisher ration had no effect on carcase weight and there was no ration x hatch interaction (Table 20.).

Table 21.

Muscle
(Kg)

	Ration 1 H Energy	Ration 2 L Energy	Ration 3 HE/LP	Hatch Average
Hatch 1	14.0	13.7	13.2	13.7 **a**
Hatch 2	13.6	14.3	13.2	13.8 **a**
Hatch 3	13.6	14.3	13.3	13.8 **ab**
Hatch 4	13.2	13.0	13.1	13.1 **c**
Hatch 5	13.3	13.0	13.9	13.3 **bc**
Ration Average	13.5	13.7	13.3	

Values in columns followed by a common letter are not significantly different ($p>0.05$)
H high, L low, HE/LP High Energy Low Protein

Table 21 shows the heavier carcases of hatches 1 - 3 cut about 500 grams more muscle than hatches 4 and 5.

All hatches produced similar amounts of total fat but finisher diet had a significant effect across hatches with birds fed the high energy finishing rations producing about a kilogram more fat. The ration x hatch interaction approached significance ($p<0.12$) and it is apparent that hatches 2 and 3 showed the greatest response to finisher diet for total fat produced (Table 22.).

Table 22.

Total Fat
(Kg)

	Ration 1 H Energy	Ration 2 L Energy	Ration 3 HE/LP	Hatch Average
Hatch 1	10.8	10.9	11.4	11.0
Hatch 2	12.4	9.9	12.8	11.5
Hatch 3	12.4	9.6	11.2	11.1
Hatch 4	10.3	11.3	11.4	10.9
Hatch 5	11.3	10.2	10.7	10.8
Ration Average	11.4 **a**	10.4 **b**	11.5 **a**	

Values in rows followed by a common letter are not significantly different ($p>0.05$)
HE/LP High Energy Low Protein

Discussion

This work shows that the impact season has on the appetite and thus growth of emus is almost independent of age and offsets any expected feed savings from late hatched birds being able to be finished at a younger age. The late hatched chicks still demonstrated a loss of appetite and slow down in growth during autumn when weighing only 15 kilograms and although they tended to grow slightly faster than earlier hatched birds during winter and respond to the increasing daylight of spring slightly earlier their live weight peaked at a lower level in December. The only hatch to suffer a significant feed disadvantage was the very early July 22 hatch which was slow to show a response to increasing daylength and ate 10 - 15 kilograms/bird more feed from hatch to slaughter.

The lower live weight plateau of the later hatched birds prior to slaughter could be expected to yield less meat and fat and results showed that birds hatched in October - November yielded 500 grams less muscle and there was a trend to produce slightly less fat.

The high energy finisher diet produced a kilogram more fat from each bird and there was an indication that the August and September hatches showed a greater response to dietary energy. Results suggest that greater responses to high energy finisher diets will be achieved if birds are introduced to them at a time when they are showing an increase in appetite.

Birds fed the low protein finisher diet grew similarly to the higher protein finisher and it is apparent that the emus have a low requirement for protein after 40 weeks of age and cost effective low protein finisher diets can be fed.

Effect of Energy Restriction and Season on Appetite and Fatness in Maturing Emus

The previous trial confirmed that the appetite of growing emus is heavily influenced by season and although chicks are hatched over a 5 - 6 month period all birds reach a peak liveweight during November - December independent of age. Once in peak condition birds commence to display mating activity and bouts of aggression and bullying can cause individual birds to lose live weight rapidly. Feed consumption declines after December and flock average liveweight will plateau and commence to fall as the birds enter their first breeding season. Liveweight can fall by as much as 25 - 30 percent during the breeding season as the birds utilise fat reserves.

Emu fat is an important emu product and current returns are maximised when birds are killed at peak fatness. However, the meat market has a strong preference for fresh product and if all birds are killed during November to January to achieve maximum fat production it creates obvious marketing problems. In an effort to supply the fresh meat demand the industry was slaughtering older birds entering their first laying season in preference to young immature birds and had reported a marked decline in fat yields when birds were slaughtered after February.

There was some evidence that under nourished birds display high levels of feed intake and fatten quickly when moved to a higher plain of nutrition as late as April and birds which have experienced a dramatic weight loss because of bullying can commence to eat and fatten late into autumn. It is also known that poorly fed flocks do not lay well during their first breeding year. This evidence suggested that emus may need to achieve a minimum level of fatness before appetite can be inhibited by season and female emus need to achieve a critical level of fatness to commence lay.

It was postulated that a feeding program which maintained maturing emus in a healthy but lean condition before they were moved onto a fattening ration just prior to slaughter would prove to be the most viable industry option. It was possible it could also reduce aggression in pens and avoid egg laying in birds destined for slaughter.

Information generated by the trial could be used to cost the alternative production strategies available to the industry for the continuos supply of both emu meat and fat.

Objective

To determine the effect of dietary energy restriction and season on appetite, live weight and fatness in maturing emus.

Experimental Method

192 mixed sex emu chicks hatched on 25 July, 29 August and 11 October 1995, 5 and 6 weeks apart respectively, and reared under the same management regime were stratified on

live weight and allocated to 24 similar 40 x 20 metre outdoor pens to achieve a similar distribution of live weight between pens.

Birds were reared on the same diet until August, 1996 when 4 of the 8 pens of each hatch date were fed diet 1 and the remaining 4 pens fed diet 2. Diet 1 was fed ad-lib. Diet 2 was initially restricted to 70 percent of the ad-lib consumption recorded for diet 1 in each proceeding fortnight. This was reduced to 60 percent after 4 weeks and retained at this level throughout the trial so as to prevent further liveweight gain. Diet 2, was formulated to provide an equivalent intake of protein, essential amino acids and minerals when fed at 70 percent of the consumption recorded for ration 1. Calculations were based on an expected ad-lib consumption of 10 MJ of energy per bird each day being reduced to 7 MJ per bird and the birds fed diet 2 achieving a 25 percent lower average live weight by December 18. After this date the restricted groups were fed sufficient to maintain live weight.

INGREDIENT	**Diet 1**	**Diet 2**	**Diet 3**
wheat	36	28	69
oats	25	18	12
barley	20		8.5
pollard	4	3.5	
lupin	10	11.5	
meatmeal	2	7.0	
bloodmeal		0.7	0.5
soya oil			5.5
limestone	0.60		1.1
dicalc. phos	2.00	1.2	2.4
salt	0.30	0.2	0.34
lysine	0.13	0.12	0.22
methionine	0.13	0.13	0.10
min/vit	0.45	0.45	0.45
TOTAL	**100.61**	**70.8**	**100.11**
Calculated Analysis %			
Protein	13.60	19.0	10.7
Lysine	0.66	1.03	0.56
Methionine	0.33	0.43	0.28
TSSA	0.62	0.75	0.52
Threonine	0.46	0.64	0.35
Tryptophan	0.15	0.20	0.12
Energy MJ/kg	11.0	10.8	13.3

On February 20 (group 1), April 16 (group 2), June 9 (group 3) and August 6 (group 4), 6 pens were selected at random; 1 from each hatch date for both diets 1 and 2, and fed diet 3, a high energy finishing diet, ad-lib. While it was initially intended to slaughter birds fed diet 3 after a period of 8 weeks this was only possible for groups 1 & 4. Groups 2 & 3 were maintained on ration 3 and slaughtered with group 4 on 24 September 1997. ie. There were 2 ration treatments X 4 groups in time blocked across the 3 hatches. Possible hatch effects were analysed on the basis of 2 ration treatments X 3 hatches replicated in time.

Measurements

Live weight and food consumption was measured each 4 weeks. Carcase weight, muscle and total fat produced at slaughter were recorded. Eggs laid were collected from each pen and recorded.

Results

Pen and treatment averages are tabled in Tables 23 to 27. Diagrams 9-12 show the live weight and food consumption of full and restricted fed emus as they were introduced to the high energy finisher ration in February, April June and August respectively.

Table 23. **Live Weight of Full and Restricted Fed Emus**

(kg)

	Ration	Hatch		28-Aug	2-Oct	30-Oct	27-Nov	18-Dec	21-Jan	20-Feb	17-Mar	16-Apr	13-May	9-Jun	9-Jul	6-Aug	4-Sep
February	Full Fed	1.- 25 Jul		37.5	43.0	46.0	48.5	48.1	47.6	48.1	49.3	49.1					
Group		2.-29 Aug		37.8	38.3	43.6	43.6	45.3	47.6	47.1	48.3	46.4					
		3.-11 Oct		31.2	37.5	40.1	41.9	42.1	42.2	42.4	42.9	42.3					
			Average	**35.5**	**39.6**	**43.2**	**44.7**	**45.2**	**45.8**	**45.9**	**46.8**	**45.9**		Full Fed Period			
	Restricted	1.- 25 Jul		39.2	40.8	39.4	39.3	38.4	39.8	37.6	41.0	41.2					
		2.-29 Aug		35.9	38.6	37.4	36.6	36.5	36.3	35.1	40.7	43.7					
		3.-11 Oct		31.5	35.2	34.0	32.9	33.1	33.0	33.5	38.6	40.3					
			Average	**35.5**	**38.2**	**36.9**	**36.3**	**36.0**	**36.4**	**35.4**	**40.1**	**41.7**					
April	Full Fed	1.- 25 Jul		37.0	42.5	44.9	45.7	45.9	46.2	45.6	39.8	43.3	43.9	42.4	40.1	39.8	43.2
Group		2.-29 Aug		37.8	41.2	44.2	44.5	45.2	45.6	43.7	43.1	41.7	42.9	43.8	43.6	44.8	46.5
		3.-11 Oct		32.4	39.8	42.6	42.7	42.2	42.1	41.1	41.1	40.8	41.7	40.2	40.6	41.2	44.1
			Average	**35.7**	**41.2**	**43.9**	**44.3**	**44.4**	**44.6**	**43.5**	**41.3**	**41.9**	**42.8**	**42.1**	**41.4**	**41.9**	**44.6**
	Restricted	1.- 25 Jul		37.2	41.5	39.3	38.5	38.3	39.6	37.9	37.7	37.9	42.7	44.7	44.8	45.0	45.7
		2.-29 Aug		36.7	39.6	37.5	36.7	36.2	36.6	34.7	35.4	35.2	43.0	44.6	43.7	45.2	49.0
		3.-11 Oct		31.6	35.3	34.8	33.7	34.1	33.4	34.4	33.1	33.6	43.3	46.2	46.5	48.1	49.5
			Average	**35.2**	**38.8**	**37.2**	**36.3**	**36.2**	**36.5**	**35.7**	**35.4**	**35.6**	**43.0**	**45.2**	**45.0**	**46.1**	**48.1**
June	Full Fed	1.- 25 Jul		39.2	44.5	45.8	49.0	48.7	47.4	44.2	37.9	39.2	38.9	39.0	42.7	45.1	48.8
Group		2.-29 Aug		37.5	41.7	43.9	46.0	47.3	46.6	47.1	46.6	44.7	43.4	41.8	40.9	40.5	44.1
		3.-11 Oct		34.8	40.1	42.4	45.0	45.9	44.6	44.3	44.8	44.1	42.1	40.6	40.9	40.7	44.1
			Average	**37.2**	**42.1**	**44.0**	**46.7**	**47.3**	**46.2**	**45.2**	**43.1**	**42.7**	**41.5**	**40.5**	**41.5**	**42.1**	**45.7**
	Restricted	1.- 25 Jul		37.3	40.5	38.6	38.9	37.8	37.7	38.5	37.2	39.4	38.1	39.3	45.4	45.7	49.2
		2.-29 Aug		37.7	40.0	38.1	37.4	37.1	36.6	35.0	35.7	34.7	33.8	33.6	39.7	43.7	50.0
		3.-11 Oct		33.2	35.6	35.3	34.4	33.7	33.6	34.3	33.5	34.7	33.9	34.3	45.2	49.3	50.8
			Average	**36.1**	**38.7**	**37.3**	**36.9**	**36.2**	**36.0**	**35.9**	**35.5**	**36.3**	**35.3**	**35.7**	**43.4**	**46.2**	**50.0**
August	Full Fed	1.- 25 Jul		39.7	44.4	45.2	46.3	45.8	45.0	45.6	43.2	40.8	39.7	38.8	37.7	38.1	40.4
Group		2.-29 Aug		34.4	39.7	41.7	43.8	45.2	45.0	44.1	43.9	42.1	39.7	39.9	38.6	39.1	42.2
		3.-11 Oct		35.7	41.1	44.5	45.7	47.4	47.6	48.0	47.8	47.5	46.9	46.5	45.9	45.7	49.3
			Average	**36.6**	**41.7**	**43.8**	**45.3**	**46.1**	**45.9**	**45.9**	**45.0**	**43.5**	**42.1**	**41.7**	**40.7**	**41.0**	**44.0**
	Restricted	1.- 25 Jul		40.5	43.0	42.3	41.6	41.6	41.9	41.7	41.2	40.8	41.0	41.4	41.3	41.4	49.3
		2.-29 Aug		39.0	38.5	38.4	38.2	37.1	37.0	36.7	37.0	35.6	34.8	34.0	34.1	34.7	42.6
		3.-11 Oct		33.8	36.7	36.1	36.4	36.3	35.7	35.8	35.1	36.4	35.2	35.3	35.6	37.2	46.9
			Average	**37.8**	**39.4**	**38.9**	**38.7**	**38.3**	**38.2**	**38.1**	**37.8**	**37.6**	**37.0**	**36.9**	**37.0**	**37.8**	**46.3**
		Full Fed	Hatch 1	38.4	43.6	45.5	47.4	47.1	46.6	45.9	42.6	43.1	40.8	40.1	40.2	41.0	44.1
			Hatch 2	36.9	40.2	43.4	44.5	45.8	46.2	45.5	45.5	43.7	42.0	41.8	41.0	41.5	44.3
			Hatch 3	33.5	39.6	42.4	43.8	44.4	44.1	44.0	44.2	43.7	43.6	42.4	42.5	42.5	45.8
		Restricted	Hatch 1	38.6	41.5	39.9	39.6	39.0	39.8	38.9	38.7	39.4	39.6	40.4	41.3	41.4	48.1
			Hatch 2	37.3	39.2	37.9	37.2	36.7	36.6	35.4	36.0	35.2	34.3	33.8	34.1	34.7	47.2
			Hatch 3	32.5	35.7	35.1	34.4	34.3	33.9	34.5	33.9	34.9	34.6	34.8	35.6	37.2	49.1
		All Groups	**Full Fed**	36.3	41.2	43.7	45.2	45.8	45.6	45.1	44.1	43.5	42.1	41.4	41.2	41.7	44.7
		All Groups	**Restricted**	36.1	38.8	37.6	37.1	36.7	36.8	36.3	36.2	36.5	36.1	36.3	37.0	37.8	

Table 24. **Feed Consumption of Full and Restricted Fed Emus**

(Grams of feed per day)

	Ration	**Hatch**		2-Oct	30-Oct	27-Nov	18-Dec	21-Jan	20-Feb	17-Mar	16-Apr	13-May	9-Jun	9-Jul	6-Aug	4-Sep	23-Sep
February	Full Fed	1.- 25 Jul		1244.0	1101.0	1050.0	797.0	691.0	640.0	707.0	532.0						
Group		2.-29 Aug		1024.0	806.0	1073.0	1060.0	889.0	604.0	659.0	545.0						
		3.-11 Oct		1166.0	1033.0	925.0	761.0	537.0	633.0	507.0	441.0						
			Average	**1144.7**	**980.0**	**1016.0**	**872.7**	**705.7**	**625.7**	**624.3**	**506.0**			Full Fed Period			
	Restricted	1.- 25 Jul		756.9	586.7	544.9	538.7	554.6	476.8	1119.2	546.4						
		2.-29 Aug		764.4	576.5	538.8	538.8	554.6	476.9	1315.4	921.4						
		3.-11 Oct		751.8	590.7	513.3	574.0	471.0	515.0	1522.5	716.9						
			Average	**757.7**	**584.6**	**532.3**	**550.5**	**526.7**	**489.6**	**1319.0**	**728.2**						
April	Full Fed	1.- 25 Jul		1250.0	1007.0	937.0	722.0	625.0	531.0	470.0	304.0	490.0	389.0	390.0	484.0	946.0	1013.0
Group		2.-29 Aug		1153.0	927.0	763.0	630.0	574.0	473.0	374.0	466.0	644.0	609.0	550.0	729.0	780.0	868.0
		3.-11 Oct		1228.0	1024.0	750.0	630.0	621.0	504.0	608.0	527.0	745.0	460.0	627.0	723.0	788.0	1123.0
			Average	**1210.3**	**986.0**	**816.7**	**660.7**	**606.7**	**502.7**	**484.0**	**432.3**	**626.3**	**486.0**	**522.3**	**645.3**	**838.0**	**1001.3**
	Restricted	1.- 25 Jul		765.1	576.0	539.0	539.0	588.0	546.0	625.0	691.0	1297.0	911.0	636.0	625.0	628.0	980.0
		2.-29 Aug		767.2	571.0	534.0	534.0	555.0	477.0	580.0	545.0	1693.0	991.0	502.0	683.0	963.0	1025.0
		3.-11 Oct		751.8	592.0	513.0	574.0	539.0	520.0	532.0	563.0	1948.0	1003.0	607.0	767.0	721.0	944.0
			Average	**761.4**	**579.7**	**528.7**	**549.0**	**560.7**	**514.3**	**579.0**	**599.7**	**1646.0**	**968.3**	**581.7**	**691.7**	**770.7**	**983.0**
June	Full Fed	1.- 25 Jul		1265.0	987.0	587.0	776.0	520.0	312.0	585.0	347.0	663.0	771.0	928.0	941.0	891.0	973.0
Group		2.-29 Aug		1202.0	961.0	857.0	812.0	598.0	587.0	508.0	496.0	442.0	392.0	553.0	669.0	844.0	1153.0
		3.-11 Oct		1200.0	1032.0	1017.0	854.0	593.0	610.0	671.0	549.0	475.0	481.0	695.0	804.0	1010.0	1316.0
			Average	**1222.3**	**993.3**	**820.3**	**814.0**	**570.3**	**503.0**	**588.0**	**464.0**	**526.7**	**548.0**	**725.3**	**804.7**	**915.0**	**1147.3**
	Restricted	1.- 25 Jul		751.1	593.0	516.0	566.0	539.0	560.0	546.0	598.0	513.0	605.0	1306.0	619.0	923.0	881.0
		2.-29 Aug		764.4	576.0	539.0	539.0	555.0	477.0	541.0	545.0	512.0	559.0	1414.0	1041.0	1283.0	1106.0
		3.-11 Oct		753.9	593.0	516.0	566.0	539.0	520.0	532.0	577.0	509.0	556.0	1940.0	1195.0	1021.0	787.0
			Average	**756.5**	**587.3**	**523.7**	**557.0**	**544.3**	**519.0**	**539.7**	**573.3**	**511.3**	**573.3**	**1553.3**	**951.7**	**1075.7**	**924.7**
August	Full Fed	1.- 25 Jul		1153.0	833.0	741.0	629.0	483.0	594.0	400.0	403.0	581.0	472.0	595.0	689.0	764.0	778.0
Group		2.-29 Aug		1141.0	959.0	855.0	871.0	579.0	473.0	485.0	362.0	347.0	476.0	449.0	466.0	838.0	831.0
		3.-11 Oct		1127.0	1049.0	955.0	935.0	629.0	559.0	604.0	648.0	551.0	632.0	551.0	800.0	933.0	1022.0
			Average	**1140.3**	**947.0**	**850.3**	**811.7**	**563.7**	**542.0**	**496.3**	**471.0**	**493.0**	**526.7**	**531.7**	**651.7**	**845.0**	**877.0**
	Restricted	1.- 25 Jul		737.8	591.0	513.0	569.0	539.0	505.0	548.0	564.0	544.0	614.0	577.0	662.0	1569.0	1247.0
		2.-29 Aug		646.8	606.0	539.0	577.0	546.0	480.0	638.0	542.0	520.0	555.0	530.0	576.0	1628.0	1039.0
		3.-11 Oct		705.6	600.0	525.0	562.0	530.0	510.0	536.0	560.0	509.0	556.0	542.0	536.0	2130.0	1981.0
			Average	**696.7**	**599.0**	**525.7**	**569.3**	**538.3**	**498.3**	**574.0**	**555.3**	**524.3**	**575.0**	**549.7**	**591.3**	**1775.7**	**1422.3**
		Full Fed	Hatch 1	1228.0	982.0	828.8	731.0	579.8	519.3	540.5	396.5	578.0	544.0	637.7	704.7	867.0	921.3
			Hatch 2	1130.0	913.3	887.0	843.3	660.0	534.3	506.5	467.3	477.7	492.3	517.3	621.3	820.7	950.7
			Hatch 3	1180.3	1034.5	911.8	795.0	595.0	576.5	597.5	541.3	590.3	524.3	624.3	775.7	910.3	1153.7
		Restricted	Hatch 1	752.7	586.7	528.2	553.2	555.2	522.0	573.0	617.7	528.5	609.5	577.0	662.0	1040.0	1036.0
			Hatch 2	735.7	582.4	537.7	547.2	552.7	477.7	586.3	544.0	516.0	557.0	530.0	576.0	1291.3	1056.7
			Hatch 3	740.8	593.9	516.8	569.0	519.8	516.3	533.3	566.7	509.0	556.0	542.0	536.0	1290.7	1237.3
		All Groups	**Full Fed**	1179.4	976.6	875.8	789.8	611.6	543.3	548.2	468.3	548.7	520.2	593.1	700.6	866.0	1008.6
		All Groups	**Restricted**	743.1	587.7	527.6	556.5	542.5	505.3	564.2	576.1	517.8	574.2	549.7	591.3		

Table 25.

Daily Gain of Full and Restricted Fed Emus

(grams per day)

	Ration	Hatch		2-Oct	30-Oct	27-Nov	18-Dec	21-Jan	20-Feb	17-Mar	16-Apr	13-May	9-Jun	9-Jul	6-Aug	4-Sep	23-Sep
February Group	Full Fed	1.- 25 Jul		182.9	107.1	89.3	-19.1	-17.4	12.8	48.0	-8.2						
		2.-29 Aug		14.3	71.4	117.9	81.0	66.4	-15.3	45.6	-66.8						
		3.-11 Oct		170.3	96.3	64.3	10.0	1.8	5.6	19.2	-21.3						
			Average	**122.5**	**91.6**	**90.5**	**24.0**	**16.9**	**1.0**	**37.6**	**-32.1**						
	Restricted	1.- 25 Jul		71.4	-50.0	-3.6	-42.9	41.2	-77.3	131.9	7.7						
		2.-29 Aug		80.0	-42.9	-28.6	-4.8	-6.7	-39.4	214.3	109.2						
		3.-11 Oct		100.0	-44.4	-39.3	10.0	-2.1	16.8	195.6	64.0						
			Average	**83.8**	**-45.8**	**-23.8**	**-12.5**	**10.8**	**-33.3**	**180.6**	**60.3**						
April Group	Full Fed	1.- 25 Jul		157.1	85.7	28.6	9.5	9.6	-22.0	-19.8	-70.5	20.6	-57.4	-57.8	-11.9	116.1	108.8
		2.-29 Aug		100.0	107.1	10.7	33.3	11.8	-64.5	-23.1	-46.7	44.4	31.7	-7.6	44.4	58.1	100.8
		3.-11 Oct		181.1	103.7	3.6	-25.0	-5.3	-32.5	0.6	-41.1	34.8	-52.4	-19.4	28.6	56.9	17.5
			Average	**146.1**	**98.9**	**14.3**	**6.0**	**5.3**	**-39.7**	**-14.1**	**-52.8**	**33.3**	**-26.0**	**-28.3**	**20.4**	**77.0**	**75.7**
	Restricted	1.- 25 Jul		122.9	-78.6	-28.6	-9.5	36.1	-60.1	-7.1	23.3	179.3	74.1	2.0	8.6	22.8	131.7
		2.-29 Aug		82.9	-75.0	-28.6	-23.8	13.9	-66.0	26.4	-8.1	291.0	60.3	-32.8	38.5	110.3	121.8
		3.-11 Oct		97.3	-18.5	-39.3	20.0	-20.8	36.0	-49.5	15.8	359.3	106.9	11.9	56.6	46.8	141.4
			Average	**101.0**	**-57.4**	**-32.1**	**-4.4**	**9.7**	**-30.0**	**-10.1**	**10.3**	**276.5**	**80.4**	**-6.3**	**34.6**	**60.0**	**131.6**
June Group	Full Fed	1.- 25 Jul		140.5	48.2	114.3	-15.0	-38.6	-108.2	-41.5	-112.4	5.4	4.4	122.7	85.7	129.0	59.0
		2.-29 Aug		120.0	78.6	75.0	61.9	-18.9	17.7	-22.5	-61.0	-4.8	-82.7	-28.3	-15.5	125.9	73.7
		3.-11 Oct		143.2	85.2	92.9	45.0	-37.6	-11.8	21.4	-24.6	-74.6	-55.0	8.1	-4.9	142.0	151.9
			Average	**134.6**	**70.6**	**94.0**	**30.6**	**-31.7**	**-34.1**	**-14.2**	**-66.0**	**-24.7**	**-44.4**	**34.1**	**21.8**	**132.3**	**94.8**
	Restricted	1.- 25 Jul		105.4	-70.4	-17.9	-15.0	-3.7	7.1	-47.4	41.4	-48.2	16.8	202.5	13.4	128.3	21.1
		2.-29 Aug		-65.7	-67.9	-25.0	-14.3	16.4	-53.2	26.2	-34.3	-34.9	-5.3	202.9	122.9	216.1	105.3
		3.-11 Oct		67.6	-11.1	-32.1	-35.0	-3.7	24.6	-31.2	24.2	-31.5	14.8	365.0	145.2	97.4	25.3
			Average	**35.8**	**-49.8**	**-25.0**	**-21.4**	**3.0**	**-7.2**	**-17.5**	**10.4**	**-38.2**	**8.8**	**256.8**	**93.8**	**147.3**	**50.5**
August Group	Full Fed	1.- 25 Jul		129.7	29.6	35.7	-20.0	-22.5	20.3	-91.3	-81.9	-40.7	-35.7	-20.5	11.2	81.8	70.7
		2.-29 Aug		151.4	71.4	75.0	66.7	-3.8	-32.5	-9.3	-58.1	-87.8	7.4	-42.5	19.9	106.8	151.1
		3.-11 Oct		146.0	125.9	42.9	85.0	4.9	13.8	-6.0	-9.9	-24.9	-12.2	-22.4	-7.7	144.0	173.7
			Average	**142.4**	**75.7**	**51.2**	**43.9**	**-7.1**	**0.5**	**-35.6**	**-49.9**	**-51.1**	**-13.5**	**-28.5**	**7.8**	**110.9**	**131.8**
	Restricted	1.- 25 Jul		67.6	-25.9	-25.0	0.0	6.9	-5.4	-18.1	-13.3	-28.9	11.7	-25.6	5.0	272.4	173.7
		2.-29 Aug		-11.4	-7.1	-7.1	-52.4	-2.0	-10.9	11.2	-45.0	-31.5	-27.8	1.1	23.2	271.8	109.7
		3.-11 Oct		78.4	-22.2	10.7	-5.0	-18.6	-6.3	-26.9	44.8	-45.7	4.9	10.0	-2.4	336.5	275.2
			Average	**44.8**	**-18.4**	**-7.1**	**-19.1**	**-4.5**	**-7.6**	**-11.3**	**-4.5**	**-35.3**	**-3.7**	**-4.8**	**8.6**	**293.6**	**186.2**
		Full Fed	Hatch 1	152.6	67.7	67.0	-11.1	-17.2	-24.3	-26.2	-68.2	-4.9	-29.5	14.8	28.3	108.9	79.5
			Hatch 2	96.4	82.1	69.6	60.7	13.9	-23.6	-2.3	-58.1	-16.1	-14.5	-26.2	16.3	96.9	108.5
			Hatch 3	160.1	102.8	50.9	28.8	-9.0	-6.2	8.8	-24.2	-21.6	-39.8	-11.2	5.3	114.3	114.4
		Restricted	Hatch 1	91.8	-56.2	-18.8	-16.8	20.1	-34.0	-24.2	17.1	-38.5	14.3	-25.6	5.0	141.2	108.8
			Hatch 2	21.4	-48.2	-22.3	-23.8	5.4	-42.4	21.2	-29.1	-33.2	-16.5	1.1	23.2	199.4	112.2
			Hatch 3	85.8	-24.1	-25.0	-2.5	-11.3	17.8	-35.9	28.3	-38.6	9.9	10.0	-2.4	160.2	147.3
		All Groups	**Full Fed**	136.4	84.2	62.5	26.1	-4.1	-18.1	-6.6	-50.2	-14.2	-28.0	-7.5	16.6	106.7	100.8
		All Groups	**Restricted**	66.4	-42.8	-22.0	-14.4	4.7	-19.5	-13.0	5.4	-36.8	2.5	-4.8	8.6		

Full Fed Period

Table 26. Conversion of Feed to Live weight gain by Full and Restricted Fed Emus

kg/kg

	Ration	Hatch		2-Oct-96	30-Oct-96	27-Nov-96	18-Dec-96	21-Jan-97	20-Feb-97	17-Mar-97	16-Apr-97	13-May-97	9-Jun-97	9-Jul-97	6-Aug-97	4-Sep-97	23-Sep-97
February Group	Full Fed	1.- 25 Jul		6.8	10.3	11.8	-41.8	-39.7	50.0	14.8	-65.2						
		2.-29 Aug		71.7	11.3	9.1	13.1	13.4	-39.6	14.5	-8.2						
		3.-11 Oct		6.9	10.7	14.4	76.1	301.6	113.1	26.4	-20.7						
			Average	**28.4**	**10.8**	**11.8**	**15.8**	**91.8**	**41.2**	**18.6**	**-31.4**						
	Restricted	1.- 25 Jul		15.1	-11.7	-152.6	-12.6	13.5	-6.2	8.5	71.4						
		2.-29 Aug		13.7	-13.5	-18.9	-113.2	-82.5	-12.1	6.1	8.4						
		3.-11 Oct		10.7	-13.3	-13.1	57.4	-220.3	30.7	7.8	11.9						
			Average	**13.2**	**-12.8**	**-61.5**	**-22.8**	**-96.5**	**4.2**	**7.5**	**30.6**						
April Group	Full Fed	1.- 25 Jul		8.0	11.8	32.8	75.8	65.4	-24.2	-23.8	-4.3	23.8	-6.8	-6.8	-40.7	8.2	9.3
		2.-29 Aug		11.5	8.7	71.3	18.9	48.8	-7.3	-16.2	-10.0	14.5	19.2	-72.3	16.4	13.4	8.6
		3.-11 Oct		6.8	9.9	210.2	-25.2	-117.2	-15.5	1104.9	-12.8	21.4	-8.8	-32.2	25.3	13.9	64.0
			Average	**8.8**	**10.1**	**104.8**	**23.2**	**-1.0**	**-15.7**	**355.0**	**-9.0**	**19.9**	**1.2**	**-37.1**	**0.3**	**11.8**	**27.3**
	Restricted	1.- 25 Jul		8.9	-7.3	-18.9	-56.6	16.3	-9.1	-88.0	29.6	7.2	12.3	318.0	72.9	30.7	7.4
		2.-29 Aug		13.2	-7.6	-18.9	-22.6	40.0	-7.2	22.0	-67.3	5.8	16.4	-15.3	17.8	8.7	8.4
		3.-11 Oct		11.0	-31.9	-13.1	28.7	-25.9	14.5	-10.8	35.8	5.4	9.4	51.0	13.6	15.4	6.7
			Average	**11.1**	**-15.6**	**-16.9**	**-16.8**	**10.1**	**-0.6**	**-25.6**	**-0.7**	**6.2**	**12.7**	**117.9**	**34.7**	**18.3**	**7.5**
June Group	Full Fed	1.- 25 Jul		9.0	20.5	5.1	-51.7	-13.5	-2.9	-14.1	-3.1	122.8	173.7	7.6	11.0	6.9	16.5
		2.-29 Aug		10.0	12.2	11.4	13.1	-31.7	33.1	-22.6	-8.1	-92.9	-4.8	-19.5	-43.3	6.7	15.6
		3.-11 Oct		8.4	12.1	11.0	19.0	-15.8	-51.6	31.3	-22.3	-6.4	-8.8	85.8	-162.8	7.1	8.7
			Average	**9.1**	**14.9**	**9.2**	**-6.5**	**-20.3**	**-7.1**	**-1.8**	**-11.2**	**7.8**	**53.4**	**24.6**	**-65.0**	**6.9**	**13.6**
	Restricted	1.- 25 Jul		10.2	-8.4	-28.9	-37.7	-146.8	79.3	-11.5	14.5	-10.7	36.0	6.5	46.2	7.2	41.8
		2.-29 Aug		16.6	-8.5	-21.6	-37.7	33.9	-9.0	20.7	-15.9	-14.7	-105.6	7.0	8.5	5.9	10.5
		3.-11 Oct		16.0	-53.3	-16.1	-16.2	-146.8	21.1	-17.0	23.9	-16.2	37.5	5.3	8.2	10.5	31.2
			Average	**14.2**	**-23.4**	**-22.2**	**-30.5**	**-86.6**	**30.5**	**-2.6**	**7.5**	**-13.8**	**-10.7**	**6.2**	**21.0**	**7.9**	**27.8**
August Group	Full Fed	1.- 25 Jul		8.9	28.1	20.8	-31.4	-21.5	29.3	-4.4	-4.9	-14.3	-13.3	-29.1	61.4	9.4	11.0
		2.-29 Aug		7.5	13.4	11.4	13.1	-153.1	-14.6	-52.0	-6.2	-4.0	64.3	-9.9	23.5	7.9	5.5
		3.-11 Oct		7.7	8.3	22.3	11.0	128.5	40.5	-100.1	-65.8	-22.2	-51.9	-24.6	-104.0	6.5	5.9
			Average	**8.1**	**16.6**	**18.1**	**-2.5**	**-15.3**	**18.4**	**-52.2**	**-25.6**	**-13.5**	**-0.3**	**-21.2**	**-6.4**	**7.9**	**7.5**
	Restricted	1.- 25 Jul		15.6	-22.8	-20.5	0.0	77.6	-93.3	-30.3	-42.4	-20.3	52.3	-22.5	132.4	5.8	7.2
		2.-29 Aug		-80.8	-84.8	-75.5	-11.0	-278.6	-44.0	57.1	-12.0	-16.5	-20.0	478.0	24.8	6.0	9.5
		3.-11 Oct		12.9	-27.0	49.0	-112.5	-28.6	-80.8	-19.9	12.5	-11.2	112.5	-54.2	-225.1	6.3	7.2
			Average	**-17.5**	**-44.9**	**-15.7**	**-41.2**	**-76.5**	**-72.7**	**2.3**	**-14.0**	**-16.0**	**48.3**	**133.8**	**-22.6**	**6.0**	**8.0**
		Full Fed	Hatch 1	8.2	17.7	17.6	-12.3	-2.3	13.1	-6.9	-19.4	44.1	51.2	-9.4	10.6	8.1	12.3
			Hatch 2	25.2	11.4	25.8	14.5	-30.6	-7.1	-19.1	-8.1	-27.5	26.3	-33.9	-1.1	9.3	9.9
			Hatch 3	7.4	10.3	64.5	20.2	74.3	21.6	265.6	-30.4	-2.4	-23.1	9.7	-80.5	9.2	26.2
		Restricted	Hatch 1	12.5	-12.6	-55.2	-26.7	-9.9	-7.3	-43.3	0.6	-15.5	44.2	-22.5	132.4	14.5	18.8
			Hatch 2	-9.3	-28.6	-33.7	-46.1	-71.8	-18.1	33.3	-31.8	-15.6	-62.8	478.0	24.8	6.9	9.5
			Hatch 3	12.6	-31.4	1.7	-10.6	-105.4	-3.6	-15.9	24.0	-13.7	75.0	-54.2	-225.1	10.7	15.0
		All Groups	**Full Fed**	13.6	13.1	36.0	7.5	13.8	9.2	79.9	-19.3	4.7	18.1	-11.2	-23.7	8.9	16.1
		All Groups	**Restricted**	5.3	-24.2	-29.1	-27.8	-62.4	-9.7	-8.6	-2.4	-14.9	18.8	133.8	-22.6		

Table 27. **Cumulative Feed Consumption of Full and Restricted Fed Emus**

(kg)

	Ration	**Hatch**		2-Oct	30-Oct	27-Nov	18-Dec	21-Jan	20-Feb	17-Mar	16-Apr	13-May	9-Jun	9-Jul	6-Aug	4-Sep	23-Sep
February Group	Full Fed	1.- 25 Jul		44	74	104	121	144	163	182	198						
		2.-29 Aug		36	58	88	111	141	159	176	193						
		3.-11 Oct		41	70	96	112	130	149	162	175						
			Average	**40**	**68**	**96**	**114**	**138**	**157a**	**173a**	**188a***		Full Fed Period				
	Restricted	1.- 25 Jul		26	43	58	69	88	103	132	148						
		2.-29 Aug		27	43	58	69	88	102	137	164						
		3.-11 Oct		26	43	57	69	85	101	140	162						
			Average	**27**	**43**	**58**	**69**	**87**	**101b**	**136b**	**158b**						
April Group	Full Fed	1.- 25 Jul		44	72	98	113	135	151	163	172	185	196	207	221	248	268
		2.-29 Aug		40	66	88	101	120	135	144	158	176	192	209	229	252	268
		3.-11 Oct		43	72	93	106	127	142	158	174	194	206	225	245	268	290
			Average	**42**	**70**	**93**	**107**	**127**	**142**	**155**	**167a**	**185**	**198**	**214**	**232**	**256**	**275**
	Restricted	1.- 25 Jul		27	43	58	69	89	106	122	143	178	202	221	239	257	276
		2.-29 Aug		27	43	58	69	88	102	117	134	179	206	221	240	268	288
		3.-11 Oct		26	43	57	69	88	103	117	134	187	214	232	253	274	292
			Average	**27**	**43**	**58**	**69**	**88**	**104**	**119**	**136b**	**181**	**207**	**225**	**244**	**266**	**285**
June Group	Full Fed	1.- 25 Jul		44	72	88	105	122	132	147	157	175	196	224	250	276	295
		2.-29 Aug		42	69	93	110	130	148	161	176	188	199	215	234	258	280
		3.-11 Oct		42	71	99	117	137	156	173	190	203	215	236	259	288	313
			Average	**43**	**71**	**94**	**111**	**130**	**145**	**160**	**174**	**189**	**203a**	**225**	**248**	**274**	**296**
	Restricted	1.- 25 Jul		26	43	57	69	88	104	119	136	150	167	206	223	250	267
		2.-29 Aug		27	43	58	69	88	102	117	133	147	162	204	233	271	292
		3.-11 Oct		26	43	57	69	88	103	117	134	148	163	221	255	284	299
			Average	**26**	**43**	**58**	**69**	**88**	**103**	**117**	**135**	**148**	**163b**	**210**	**237**	**268**	**286**
August Group	Full Fed	1.- 25 Jul		40	64	84	98	114	132	142	154	170	183	201	220	242	257
		2.-29 Aug		40	67	91	109	129	143	156	166	176	189	202	215	239	255
		3.-11 Oct		39	69	96	115	137	153	169	188	203	220	237	259	286	306
			Average	**40**	**66**	**90**	**107**	**126**	**143**	**156**	**170**	**183**	**197**	**213**	**231**	**256**	**273**
	Restricted	1.- 25 Jul		26	42	57	69	87	102	116	133	148	165	182	200	246	270
		2.-29 Aug		23	40	55	67	85	100	116	133	147	162	178	194	241	261
		3.-11 Oct		25	41	56	68	86	101	115	132	146	161	177	192	254	291
			Average	**24**	**41**	**56**	**68**	**86**	**101**	**116**	**133**	**147**	**162**	**179**	**195**	**247**	**274**
		Full Fed	Hatch 1	43	70	94	109	129	144	158	170	177	191	211	230	255	273
			Hatch 2	40	65	90	108	130	146	159	173	180	193	209	226	250	268
			Hatch 3	41	70	96	112	133	150	166	182	200	214	233	255	281	303
		Restricted	Hatch 1	26	43	58	69	88	104	119	137	149	166	182	200	251	271
			Hatch 2	26	42	57	69	87	102	117	133	147	162	178	194	260	280
			Hatch 3	26	43	57	69	87	102	116	133	147	162	177	192	271	294
		All Groups	Full Fed	41	69	93	110	131	147	161	175	186	200	217	237	262	281
		All Groups	Restricted	26	42	57	69	87	103	117	135	148	163	179	195		

***** Within groups treatment averages followed by an uncommon subscript are significantly different (P<0.05)

Diagram 9.

Feed Consumption and Live Weight of Full and Restricted Fed Emus fed a High Energy Finisher Ration Ad-lib in FEBRUARY

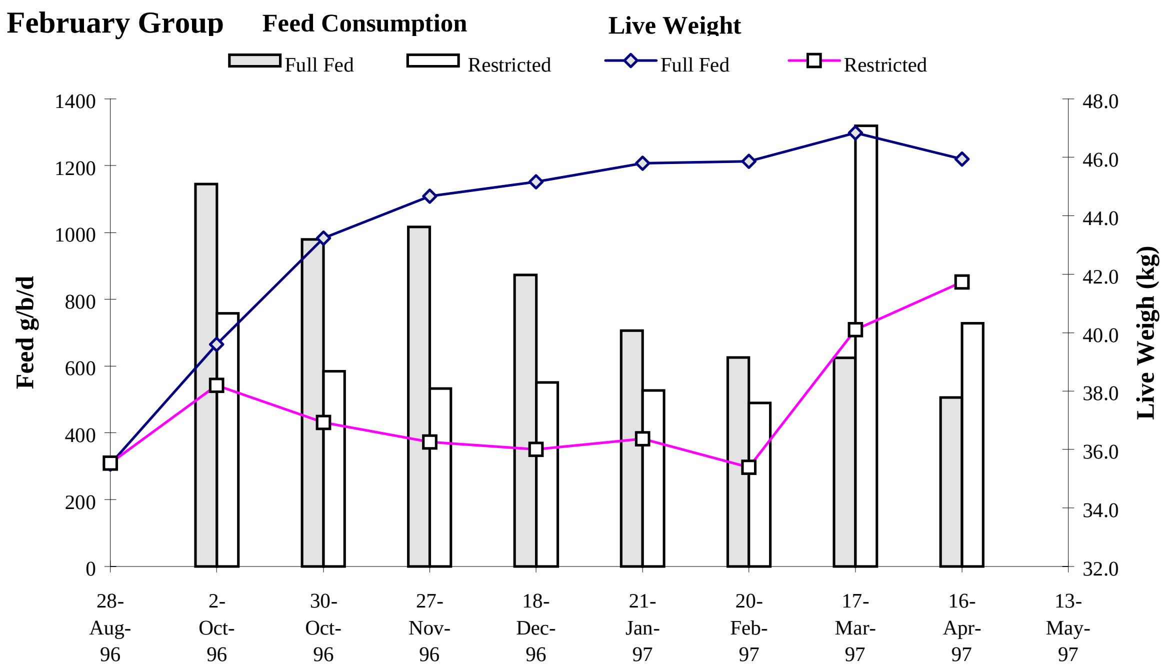


Diagram 10.

Feed Consumption and Live Weight of Full and Restricted Fed Emus fed a High Energy Finisher Ration Ad-lib in APRIL

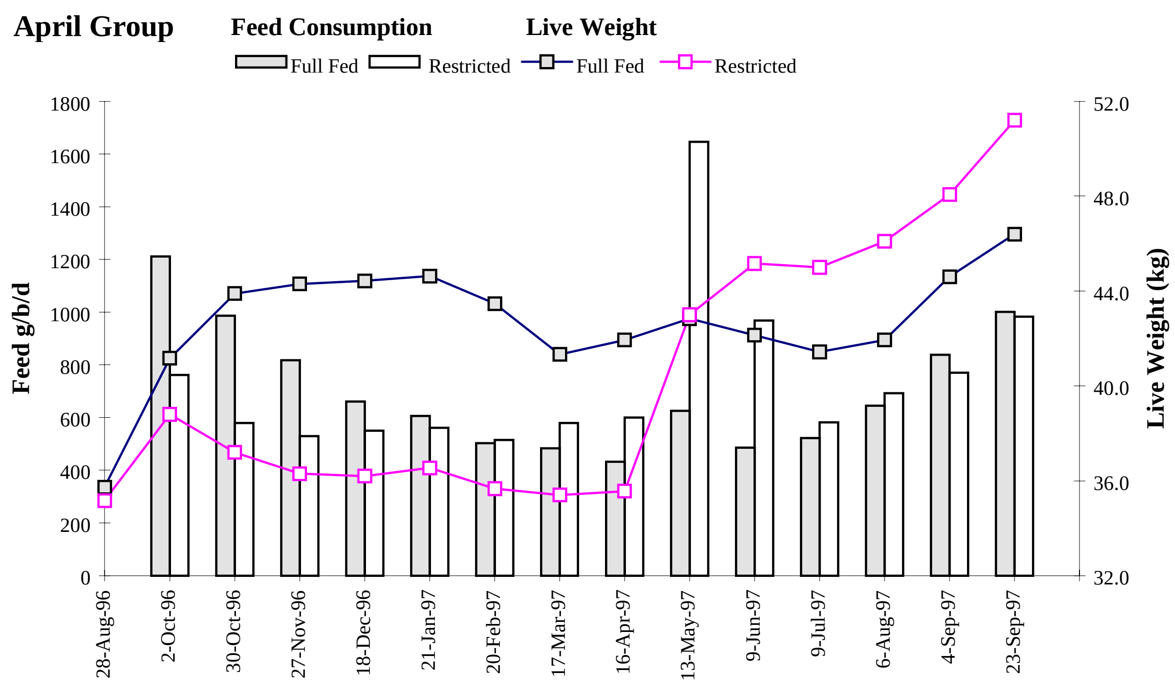


Diagram 11.

Feed Consumption and Live Weight of Full and Restricted Fed Emus fed a High Energy Finisher Ration Ad-lib in JUNE

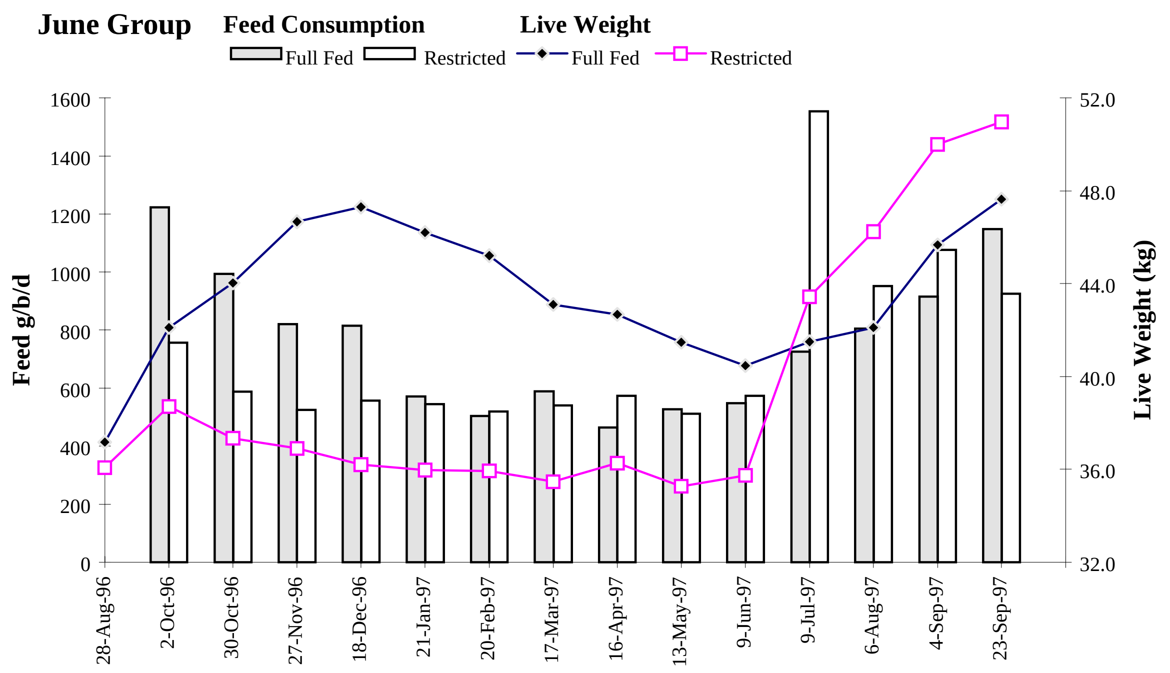
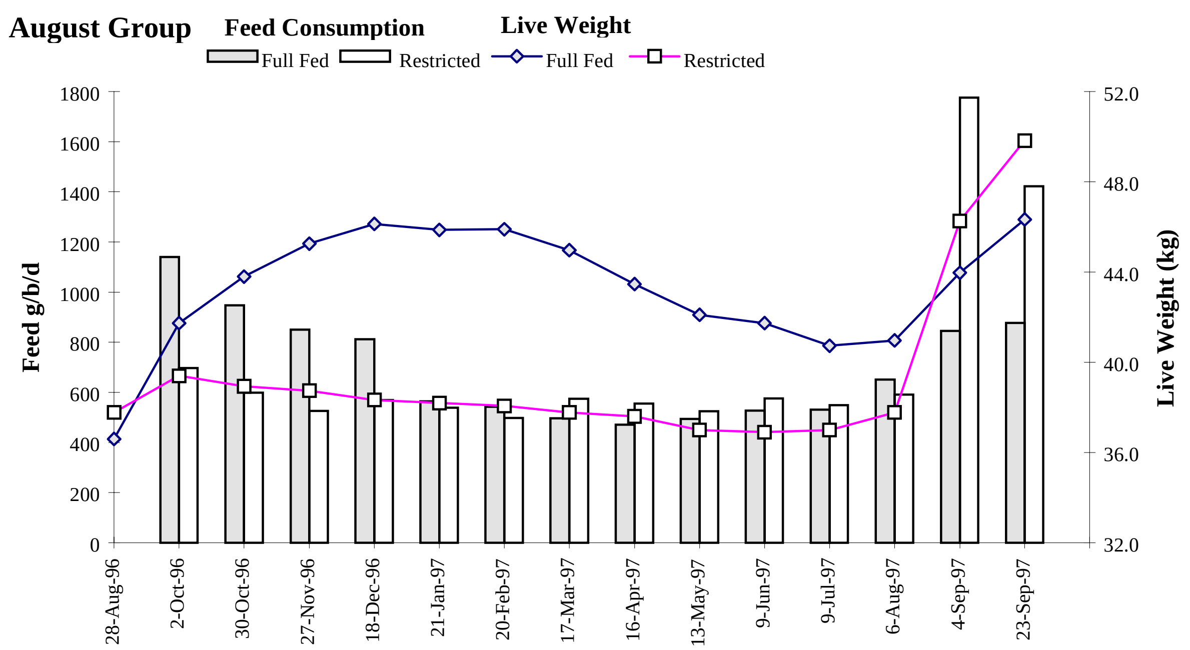


Diagram 12.

Feed Consumption and Live Weight of Full and Restricted Fed Emus fed a High Energy Finisher Ration Ad-lib in AUGUST



Level of Restriction
On December 18 the live weight (Table 23.) of the restricted fed groups averaged 36.7 kilograms or 80 percent of the 45.8 kilograms recorded for the full fed group. This had been achieved by restricting their feed to 63 percent of the feed eaten by the full fed groups (110 kg versus 69 kg - Table 27.)

Diagrams 9 - 12 show that feed consumption and live weight of the restricted birds increased dramatically for 4 - 8 weeks after being given free access to feed. The gain in live weight of the restricted birds 4 weeks after being given free access to feed in April, June and August averaged 7.9 kg. However, the February group showed only a 4.7 kg gain at 4 weeks and a further 1.6 kg at 8 weeks. The response of restricted fed birds in this group when given free access to feed was different ($P<0.045$) to all other groups and it was excluded from the combined analysis of the April to August data which showed no ration by group interaction (Table 28.). Restricted birds in the April, June and August groups reached and maintained a heavier liveweight after 8 weeks on full feed. There was a trend for the initial response to full feeding to be greater as full feeding commenced later in the year.

Table 28.

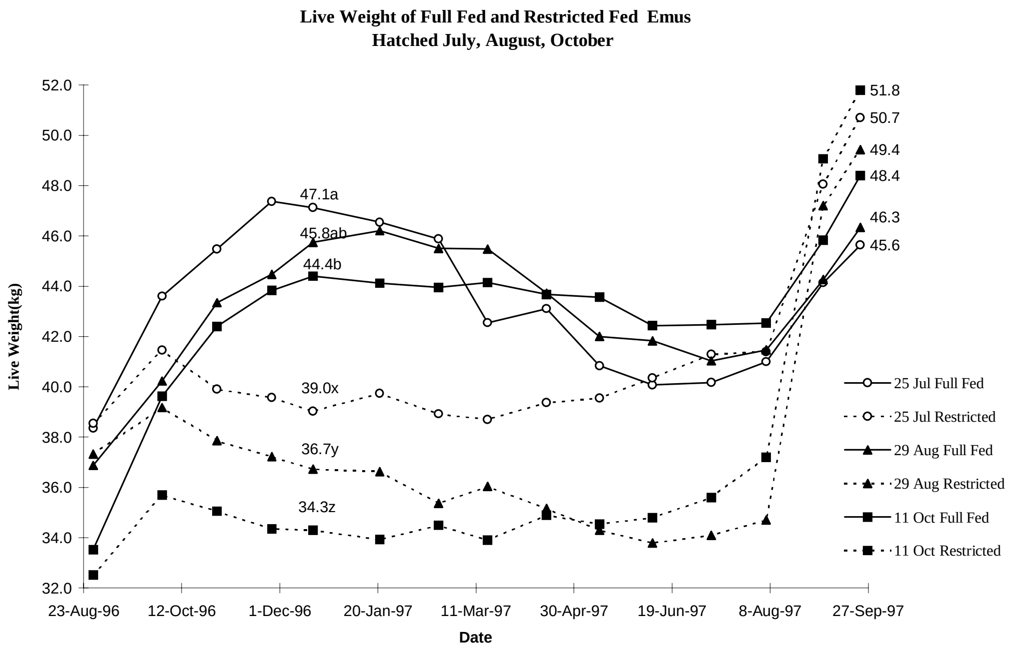
Live Weight of Emus Following a Period of Feed Restriction

		Months on Full Feed						
Group	**Ration**	**0**	**1**	**2**	**3**	**4**	**5**	**6**
April	Full Fed	41.9a	42.8	42.1	41.4b	41.9b	44.6	46.4b
	Restricted	35.6b	43.0	45.2	45.0a	46.1a	48.1	51.2a
June	Full Fed	40.5a	41.5	42.1b*	45.7b	47.6b		
	Restricted	35.7b	43.4	46.2a	50.0a	51.0a		
August	Full Fed	41.0a	44.0	46.3b				
	Restricted	37.8b	46.3	49.8a				
	SED*	1.33	1.24	1.53	1.22	1.29	0.97	0.95
	LSD**	2.95		3.40	2.99	3.16		4.10

*Within groups values in columns followed by a common subscript are not different ($P>0.05$)
SE Standard errors of differences of means (ration);
LSD Least significant differences of means $P<0.05$ (ration)

Effect of Hatch Date
Diagram 13 is consistent with information collected in the previous trial ie., the liveweight of all full fed pens reached a seasonal peak in December and earlier hatches were heavier than later hatches. It is of interest that the live weights recorded the following September suggested that this trend had been reversed.

Diagram 13.



Feed Consumption

Daily feed consumption

Feed consumption of the restricted fed birds increased dramatically once they were given free access to feed (Table 29.). There was also an additive seasonal effect which increased the level of daily feed intake of the August group during the second month of full feed and caused the June group to eat more than the April group during their third and fourth months on full feed.

Table 29.

Daily Feed eaten by Full and Restricted Fed emus When Fed a High Energy Finisher Ration Ad-lib

(g)

		Months on Full Feed						
Group	**Ration**	**0**	**1**	**2**	**3**	**4**	**5**	**6**
February	Full Fed	626	624a*	506b				
	Restricted	490	1319a	728a				
April	Full Fed	432	626b	486b	522	645	838	1001
	Restricted	600	1646a	968a	582	692	771	983
June	Full Fed	548	725b	805	915**	1147**		
	Restricted	573	1553a	952	1076**	925**		
August	Full Fed	652	845b	877b				
	Restricted	591	1776a	1422a**				
	SED*	47.2	78.5	89.4	73.7	69.3	144.6	97.3
	LSD**	ns	168.4	191.7	ns	ns	ns	ns

*Within groups values in columns followed by an uncommon subscript are different (P < 0.05)
** Significantly higher than other groups (P < 0.05)
SED Standard errors of differences of means (ration);
LSD Least significant differences of means P<0.05 (ration)

Cumulative feed

With the exception of the February group the high level of feed consumption recorded for restricted fed emus placed on full feed meant that cumulative feed consumed became similar for both restricted and full fed groups after only 4 - 8 weeks of full feeding (Table 27.). Cumulative feed consumed by the February group was still less when the birds were slaughtered in April.

Slaughter

Table 30. shows slaughter details for groups slaughtered in April and September.

Table 30.

Live weight at slaughter and products yielded by full and restricted fed emus

Group	Ration	Live Weight	Carcase*	Muscle	Total Fat
February	Restricted	45.9	18.4	14.6	10.9a**
	Full Fed	41.8	18.1	14.1	8.0b
	SED	2.22	0.71	0.51	0.96
	LSD	ns	ns	ns	2.67
April	Full Fed	46.4b	18.39	14.13	10.17b
	Restricted	51.2a	19.27	14.84	12.77a
June	Full Fed	47.6b	18.74	14.43	10.11b
	Restricted	51.0a	19.01	14.61	12.35a
August	Full Fed	46.3b	18.49	14.22	10.09
	Restricted	49.8a	19.24	14.80	11.81
	SED	1.48	0.47	0.34	0.82
	LSD	3.30	ns	ns	1.82

*Carcase - Rib cage and neck removed
** Within groups values in columns followed by a different subscript are different (P>0.05)
SED Standard errors of differences of means (ration);
LSD Least significant differences of means P<0.05 (ration)

Birds restricted fed until February produced similar amounts of muscle but less fat when slaughtered after 8 weeks of ad-lib feeding. Birds restricted fed until April, June and August and slaughtered after 24, 16 and 8 weeks ad-lib feeding respectively were heavier at slaughter and produced more fat. There was also a consistent trend for restricted groups to produce more muscle.

Sex

Birds were sexed at slaughter and trial data was examined retrospectively for possible treatment by sex interactions. Diagrams 14 and 15 show that while female emus were consistently heavier both sexes behaved similarly to the treatments imposed.

Diagram 14.

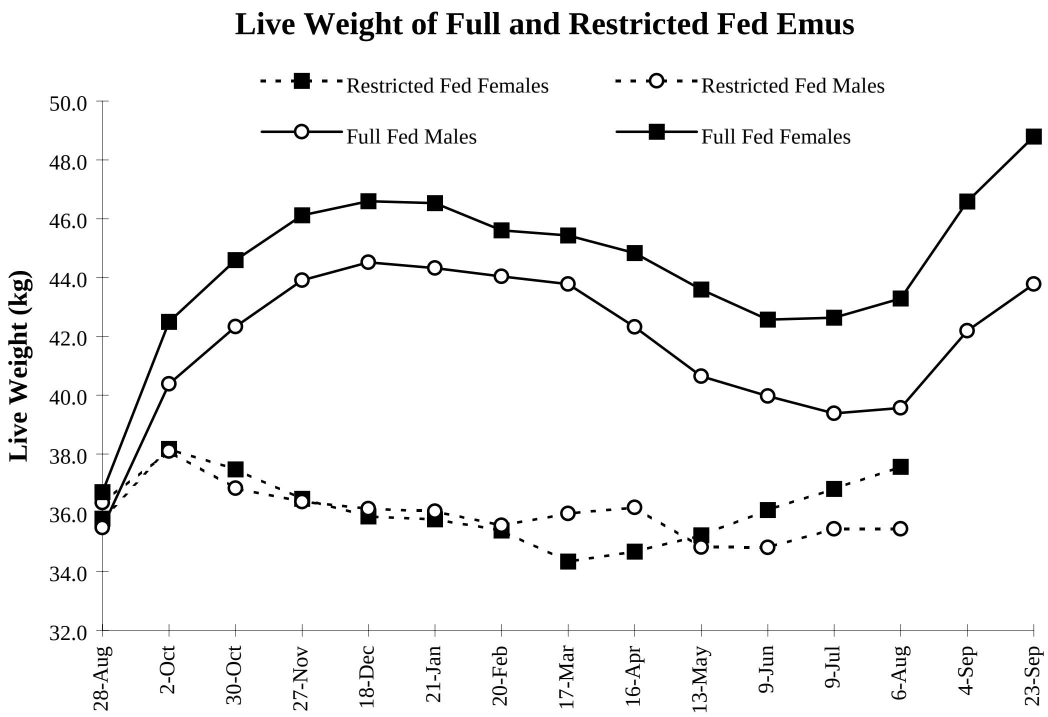
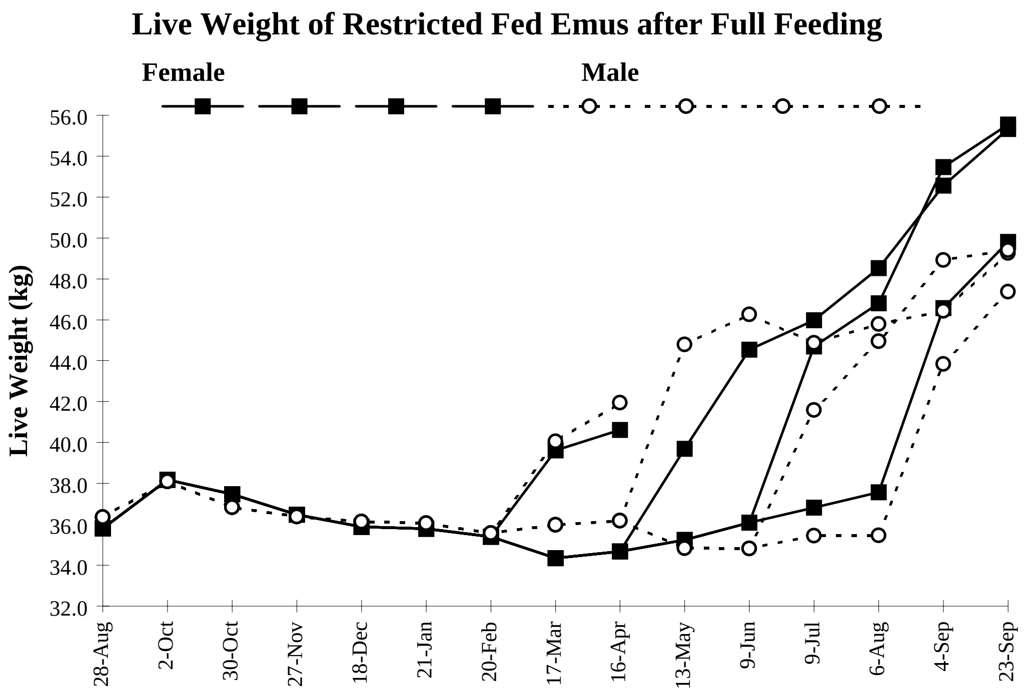


Diagram 15.



Tabulation of the slaughter data on the basis of ration by sex suggests that while females consistently produce more muscle the males may show a greater response to feed restriction by producing more fat (Table 31.).

Table 31.

Products yielded by full and restricted fed emus of different sex

	Ration	Live Weight	Carcase	Muscle	Total Fat
Female	Full Fed	48.9	19.64	15.10	10.27
	Restricted	49.13	19.80	15.18	10.54
Male	Full Fed	43.5	17.34	13.61	10.33
	Restricted	47.29	18.19	14.15	11.62

Fighting in Pens

Fighting occurred in all pens and the scoring of birds for damage within pens each week was abandoned. Bouts of aggression in pens were noted and the number of birds recording a weight loss of more than 2.5 kilograms between weighings was recorded (Table 32.). Birds which were being continually bullied were removed from the trial.

Table 32.

Birds recording a live weight loss of more than 2.5 kilograms and birds removed throughout the trial

Group	Ration	Female	Male	Total	Removed
February	Full Fed	3	3	6	0
	Restricted	5	4	9	1
April	Full Fed	7	2	9	3
	Restricted	3	4	7	3
June	Full Fed	7	5	12	4
	Restricted	1	8	9	6
August	Full Fed	5	3	8	1
	Restricted	2	4	6	4

Feed restriction had no measurable effect on the incidence of aggression between birds throughout the trial. However, it was observed that aggression did increase in the restricted fed birds within 4-6 weeks of them being placed on full feed.

Although egg production records were lost it was observed that the April group of birds were slaughtered before they came into production. Seven of the 9 remaining full fed pens commenced to lay consistently from May 20. One of the remaining pens laid only occasionally and one pen never laid.

Only one of the restricted fed pens commenced to lay regularly on May 23 and 3 other pens still produced the odd egg while being restricted fed. Once full fed one pen in the April fed group laid consistently after 4-6 weeks feeding but all other pens did not lay. It is clear that the level of feed restriction imposed greatly reduced but did not prevent egg production.

Discussion

This trial demonstrated that emus restricted fed so as to maintain an average live weight of 32.5 to 38.4 kilogram can be fattened and slaughtered at an average live weight of greater than 45 kilograms from April to August within 8 weeks of feeding a high energy finisher diet ad-lib. Although a slaughter weight of only 41.7 kilograms was reached within 8 weeks of full feeding in February the response of the April group indicated that the 45 kilogram kill weight should have been achieved with a further 4 weeks feeding.

Each bird consumed approximately 75 kilograms of finisher ration to achieve a slaughter weight of greater than 45 kilograms. Cumulative feed consumption of the restricted fed birds after the 8 week full feeding period was similar to full fed controls and there was no overall saving in feed. They were however, heavier and could be expected to yield about 2 kilograms more fat at slaughter.

Restriction did not completely eliminate the effect of season and the restricted birds full fed in February did not show the same level of response as birds full fed later in the year. There was also a trend for the response to increase as the birds approached their normal fattening season.

While the feed restriction did reduce egg production it did not completely eliminate it. Results also suggest that it could be possible to commence restriction at even lower live weights without any detrimental effect on final live weight and product yields.

Although feed restriction did not measurable reduce aggression within the pens the 3 days a week feeding regime adopted for the trial did not result in individual dominate birds becoming substantially heavier than their pen mates. The problem of aggression was greatly accentuated by confining sexually mature birds in 40 X 20 metre trial pens. The results suggest that fatness is not directly linked to sexual activity and the mechanisms controlling seasonal appetite are independent of those controlling seasonal breeding.

Date of hatch and sex of the birds had no effect on the way the birds responded after the feed restriction was lifted.

While the information collected in this and the previous trial could be used to model the most profitable production options for a range of industry price and cost structures it was beyond the resources of this project. Partial analysis does show that for a wide range of product prices income will be maximised when birds are slaughtered between 56 and 72 weeks of age with the earlier hatched birds being full fed and slaughtered first and the later hatches being restricted fed from 32.5 kilogram live weight and slaughtered at the older ages after being fed a high energy finishing ration for 8 - 12 weeks. While this will confine the supply of fresh product from September to May each year the killing of birds outside this age range has a considerable cost penalty.

The previous trial showed that season also impacts on the appetite of younger early hatched emus during their first year of growth and the restricted feeding of these birds prior to finishing for slaughter is likely to enable them to be slaughtered at a younger age at reduced cost. This warrants investigation.

This work and research reported by the University of Western Australia (RIRDC project no UWA-25A) suggests that the physiological mechanisms governing appetite in the emu are independent of those governing sexual expression and aggression. An understanding of the control of appetite and its manipulation would undoubtedly increase the ability of the industry to fatten birds on demand throughout the year and remove the current restrictions imposed by season. This work however, shows there is considerable advantage in restricting the diet of emus, particularly those destined for slaughter at ages older than 12 months, until 2 - 3 months prior to slaughter. It also supplies data on the effect of hatch date which could be used to model optimum production options for the industry.

Publications

O'MALLEY P.J., (1998) Emu Farming. *The New Rural Industries - A Handbook for Farmers and Investors* Edited by K.W. Hyde.

MALEKI I. A., MARTIN G.B.,O'MALLEY P.J., MEYER G.T.,TALBOT R.T., SHARP P.J., (1998) Endocrine and testicular changes in a short-day seasonally breeding bird, the emu (*Dromaius novaehollandiae*), in southwestern Australia. *Animal Reproduction Science* 53 (1998) 143-155.

FRAPPLE P., O'MALLEY P. J., SNOWDEN J., HAGAN R., (1997) Emu Processing and Product Development. *RIRDC Research Paper Series No 97/66 Project No DAW-34A.*

O'MALLEY P.J. (1996) An estimation of the nutritional requirements of emus. (Keynote Address) Proceedings *Improving Our Understanding of Ratites in a Farming Environment* Edited D. C. Deeming

SHARP P.J., TALBOT R.T., O'MALLEY P.J., TAN S.N., WILLIAMS K.M., BLACKBERRY M.A., MARTIN G.B., Neuroendocrine Control of Incubation Behaviour in the Emu. Proceedings *Improving Our Understanding of Ratites in a Farming Environment* (Manchester March 1996) Edited D. C. Deeming

O'MALLEY P.J. (1995) Nutrition of Ratites: Comparison of Emu and Ostrich Requirements. (invited paper) Proceedings *Recent Advances in Animal Nutrition in Australia 1995* Edited J. B. Rowe & J. V. Nolan.

O'MALLEY P.J. (1996) Bird Handling and Handling Facilities Proceedings *Third World Emu Congress* Adelaide.

O'MALLEY P.J. (1996) Egg Collection handling and Hygiene. Proceedings *Producing the Chick Seminar.* Emu Producers Association of Victoria - Bendigo

O'MALLEY P.J. (1996) Incubation and Hatching. Proceedings *Producing the Chick Seminar.* Emu Producers Association of Victoria - Bendigo

O'MALLEY P.J. (1996) Brooding and Care of Young Chicks. Proceedings *Producing the Chick Seminar.* Emu Producers Association of Victoria - Bendigo

O'MALLEY P.J. (1995) De-clawing Emu Chicks Agriculture Western Australia, refer author.

O'MALLEY P.J. (1995) Rations for Emus *Australian Emu* January/February 1995

O'MALLEY P.J. (1995) Managing your Emu Flock Australasian Poultry Vol 6 No 1.

O'MALLEY P.J. (1995) Emus, Producing and Hatching Eggs *Australasian Poultry* Vol 6 No2.

Appendix 1

TRAVEL REPORT

Peter O'Malley

ATTENDANCE

"Improving Our Understanding of Ratites In a Farming Environment"

Manchester England
March 27 - 29 1996

SUMMARY

The conference "Improving Our Understanding of Ratites In a Farming Environment' held at Manchester England, March 27 - 29 was attended and a paper " An estimate of the nutritional requirements of Emus" presented. The conference was well attended and provided an excellent forum for the exchange of knowledge and concepts on the future research needs of the emu and ostrich industries.

Internationally emus were proving to be highly reproductive and much more easily reared than Ostriches. There was very little new information on emus presented outside that initiated from within Australia.

Emu products were virtually unknown in England but an opportunity existed for market promotion to be carried out with the assistance of Western Australian House and the offices of Austrade.

Attempts should be made to stream line importation procedures for meat entering England and further product development work is required.

It was found that the industry had no marketing presence in Europe and value was seen in targeting markets already buying ostrich and forming an alliance with existing European producers.

More developmental work was required to bring emu body leather up to an international standard and leather promotion should be targeted toward markets in Asian.

Itinerary

Wednesday 20 March 96	Travel Perth to London via Singapore
Thursday 21 March	Arrive London Meet Grahame Igglesden Manager Investment and Trade Western Australian House 115 Strand London WC2R OAJ
Friday 22 March	Appointments with Mr J.C. Thurlow S.O. Rowe and Son PLC 36/40 Tanner Street. Tower Bridge Road London England SE1 3LH Philip Szlapak Rudston Products (Int) Ltd.,

	Unit 5. New Concordia Wharf, Mill Street, London SE1 2BA
Monday 25 March	Appointments with Nils Lungren Business Development Manager Australia House, Strand, London England WC2B 4LA Michael Hampton Meat Importer 10 Bronwen Court Grove End Road London NW8 9HH Puntrella and Son 8 Westerham Ave. Edmonston London N99 BU
Tuesday 26 March	Travel to Manchester and registration for conference
Saturday 30 March	Depart Manchester travel to Paris Via London
Monday 1 April	Appointment with Anne Borgo Marketing Officer Austrade Paris Australian Embassy 4, rue Jean Reay 76724, Paris cedex 15
Phone contact with	Mr Texiel / Mr Chavinski Generale de Importation 40 Rue du Seminaire BP 430 Rungis 9415 Jacque Lanoux Aussie Trend 16 Rue Jean Jaures 21120 Is-Sur-Tille

Tuesday 2 April	Appointment with Hervé Loubert Gordon - Choisy 17 Boulevard Jules Ferry 75011 Paris
Wednesday 3 April	Travel to Gâtines France meet with Alain Sauvage Chairman and Managing Director France Autruches Gâtines 44520 ISSE France
Thursday 4 April	Return to Perth via Paris, London, Singapore.

TRAVEL REPORT

Purpose

The purpose of the travel was to attend the first international ratite conference - Improving Our Understanding of Ratites in a Farming Environment and present a Keynote address titled " An Estimate of the Nutritional Requirements of Emus."

It also presented the opportunity to:

- review innovative approaches and the methodology being adopted to determine the nutritional requirements of ostriches, emus and rheas.

- become aware of the problems faced by other nations in the farming of ratites.

- discuss the possible application of new technologies and innovative approaches to overcome current limitations to emu production with the view of initiating collaborative research at an international level.

- make direct contact with personnel associated with large ostrich and emu producing companies located in Europe, South Africa and Israel.

- determine specific specification and market requirements for the export of emu products to Europe.

- initiate new export enquiries for emu products.

- identify specific market opportunities for the emu industry.

- answer specific questions importers may have on the nature and size of the Australian emu and ostrich industries.

Outcomes

Ratite Conference

This was the first international scientific conference on ratites aimed at improving the scientific understanding of emus, ostriches, and rheas in a farming environment. It was well supported with more than 120 scientists specialising in ratite research attending. Delegates represented 20 individual countries and 63 papers and 14 posters were submitted for publication in the proceedings. Only 10 papers related specifically to emus with the majority dealing with Ostriches.

Papers could be grouped into 7 broad topics:

- Anatomy and Morphology - 9 papers
- Behaviour - 5 papers
- Disease and Veterinary Aspects - 17 papers
- Husbandry, Genetics and Production - 6 papers
- Nutrition - 5 papers
- Physiology and Biochemistry - 6 papers
- Reproduction and Incubation - 15 papers

The conference was well run and ideas and information was freely exchanged between delegates. Although the conference was heavily supported by ostrich interests it became clear that throughout the world achieving good levels of production from ostriches would remain a problem for some time. The emu however, is proving to be highly reproductive, hardy and much easier to produce than the ostrich.

The amount of new information presented on emus was disappointing but discussions with the nutritionists responsible for formulating ratite diets in England and America were of value. A paper showing that young emus digest plant fibre supplied by pollard and soya bean hulls poorly supports the view that specialised pastures of easily digested plant material will need to be identified for the pasture finishing of emus to become a reality. This paper also confirmed that dietary manganese had to be maintained in excess of 200 ppm to maintain a positive manganese balance.

Leg problems in young emus remain a major cause of loss throughout the world and it appears unlikely that the work needed to gain a better understanding of the problem will be available in the short to medium term.

Trade contact - leather

Emu

Samples of leather and products were shown to the three tanners visited. All were of the opinion that attempts should be made to improve the quality of the tan, achieve a better adhesion of the grain layer and gain a better lifting of the follicle. It was thought that this would be achieved by the correct vegetable/chrome tan combination. Once tanned to the crust stage different finishes could be applied to produce a product suitable for the accessory trade or a product for garments. Both Rowe and Son and Gordon Choisy had tanned emu but neither would be prepared to invest in the development work they felt was necessary before a clear demand for the product had been demonstrated. They recognised that emu was not known to the trade and a large promotion and marketing campaign was needed to introduce it.

France Autruches had attempted to enter into an exclusive arrangement with a local company for the tanning of emu but this was rejected. They were now tanning in Italy and were very pleased with the leather being produced. While they could not show me a sample of this leather they had only recently slaughtered 100 emus for the prime purpose of supplying an order for body skins. The body skins on show were of a standard similar to that achieved in Australia.

It was felt there would be a ready market for leg skin in the boot and accessory trade and agreed that initially leg skins could be expected to sell better than body skins. Tannage of leg skin was not a problem.

Ostrich

Both tanners were purchasing and tanning ostrich and were looking to buy salted skins at a price of $25 - $30 a square foot. Gordon Choisy was buying 400 a month from the Israel kibbutz cooperative Zemach and expected this to increase to 800 within 12 months. Skins were also being sourced from South Africa and America. The finished leather varied between the tanners with the product from Gordon Choisy appearing to be thicker but softer.

France Autruches had their skins tanned in Italy and the range of ostrich leather accessories displayed in their offices was impressive.

Asian markets accounted for the majority of sales in exotic leather but the single biggest market is the American boot market which buys more than 30 percent.

Meat

Emu meat is virtually unknown in England and the British Ministry had records of only 2 consignments in the 12 months prior to my visit. Only one of the importers contacted had recently imported emu but all requested more information on the product and possible sources of supply. The English meat trade and consumer does not know what emu meat is and an industry marketing effort would be needed to sell significant volumes of meat into this market. The Offices of Austrade are available to hold promotions which could be organised through Western Australia House, with a lead up time as short as 8 weeks, at minimal cost.

The current method of packaging into fore and hind saddle and drum does present problems to importers who would prefer "customer ready packs". This would add substantially to the preparation cost of the meat but development work in this area is obviously warranted. The concept of reforming the smaller muscles into steaks or cutlets 2 - 3 cm thick, similar in concept to the reformed lamb steaks being trailed by the Lamb Marketing Authority, appealed to importers.

Problems had been experienced in getting consignments of meat through Heathrow airport and although this was expected to improve if shipments became regular it was seen as a problem. It was necessary to obtain a license from the British Ministry for Farming and Fisheries for each consignment imported.

France Autruches will be producing 5- 6000 emus, and a similar number of ostriches, this year and will not be importing emu from Australia. It recognises that emu meat is unknown relative to ostrich but considers it to be a slightly better product. Both products adapt well to French cuisine and are often served raw. Meat from culled breeding birds was considered to be acceptable.

Increasing quantities of ostrich are being imported into both England and France at a price of around $10 per kg. Standard cuts retail at the sirloin beef price of $25/kg but ostrich fillet sells for as much as $50/kg.

General

The France Autruches operation was integrated with growers being contracted to farm the birds on a contract wage basis. Emu breeders had been successfully moved into buildings and each pair housed in solid walled 3 x 3 metre pens for the breeding season. Production averaged more than 20 eggs per bird and 70 percent of all eggs set hatched. The move to intensive housing reduced the labour cost dramatically and improved hatchability by reducing the number of rot infected eggs. It also opens up the possibility of artificial light control of the breeding season. Birds appeared to be contented and laying well.

Ostriches were being intensively penned in 5 x 5 metre pens with open mesh to the outside.

They have maintained complete breeding records on all stock and adopt a policy of replacing a minimum of 25 percent of their breeders each year with selected stock. This is expected to achieve a significant level of genetic gain and while it was not possible to accurately judge the size and conformation of their stock they did appear smaller than Australian stock.

It is clear that this company can be seen as an initial major competitor to the Australian Industry to the limit of their current production capacity. Beyond this I feel it would be in the interests of Australian producers to attempt to form an alliance with the company and share market development and promotion costs in the knowledge that in the long term competition will be largely determined by customer service and price competitiveness.

Benefits/significance to the grantee

The visit to England has enabled the grantee to obtain a clear picture of the present structure, production capacity and technical knowledge of the international ratite industry. Personal contact has been established with a number of people closely involved in the establishment and promotion of the industry and research workers currently conducting or interested in emu and ostrich research.

The conference provided a unique opportunity for personal contact and discussion with scientists with a wide range of expertise in avian research. This supplied background information for future directions of research and resource persons willing to offer ideas and comment.

Recommendations to industry

1. To date the industry has failed to address the marketing strategies addressed in the report "A Development Strategy for the Emu Industry" by ACIL Australia (1992), and this fact has been raised on a number of occasions. Action in this area has now been initiated at a national level through the Strategic planning workshop held in February and at the State level at a meeting in April. A source of funding for this work is yet to be identified and needs immediate resolution.

2. An opportunity exists for the industry to utilise the resources of Western Australia House and Austrade in London to undertake a promotion of emu meat.

3. There is a need to understand more about competitive products and markets currently selling ostrich could be targeted.

4. Opportunities for adding value to the meat by further processing and supplying it in "super market ready" packs should be examined.

5. The potential to sell the smaller muscles as reformed steaks needs evaluation.

6. The industry should consider establishing processing and marketing joint venture arrangements with overseas companies interested in emu products.

7. Further research and development work to produce emu body leather to an internationally accepted standard is required.

8. There is a need for co-ordination and co-operation in product development.

9. Procedures for the importation of emu products into target countries need to be tabled, clarified and streamlined where possible.

Acknowledgments

The travel costs were funded by the Rural Industries Research and Development Corporation and the organisers of the Ratite conference and there support is gratefully acknowledged. I thank Agriculture Western Australia for providing the opportunity for me to participate in the conference.

Part B

Leather

by Peter O’Malley and John M. Snowden
Agriculture Western Australia

CONTENTS

Executive Summary

De-clawing

The possible use of gas anaesthesia, and a range of alternate techniques for the removal of the claws from recently hatched emu chicks were trialed. Three of the identified techniques, hot blade beak trimming machine, hot blade beak trimming machine fitted with a modified blade and an electric arc Bio-Beaker™ were compared in a larger experiment. A further experiment investigated the use of a topically applied analgesic prior to and following the removal of the claw using a hot blade beak trimming machine.

Gas anaesthesia proved difficult and the possibility of developing an apparatus which would induce general anaesthesia in large numbers of emu chicks appeared remote. Further work was abandoned.

The use of constricting rubber rings, liquid nitrogen and a cold blade without cauterisation to de-claw emu chicks was either difficult to apply or resulted in significant regrowth of the claw.

A major finding was that the retention of the pad under the claw during the de-clawing procedure resulted in the formation of a pad at the end of the emus' toe. This was obviously desirable as it provided a cushion to the end of the toe which produced an increased toe length and a more "normal" looking toe. Further investigation of methods which retained the end toe pad and the possible modification of technique when using the hot blade de-beaker was warranted. The only concern with such methods was the increase in wound area and possible longer healing times which resulted.

A large scale experiment to compare the Bio-Beaker, a de-beaking machine with a standard blade and one with a blade modified to retain a maximum amount of pad tissue under the claw confirmed that de-clawing techniques which retained portion of the toe pad under the claw resulted in the development of a protective pad at the tip of the toe.

The measurement of feed consumption and live weight suggested that chicks de-clawed using the bio-beaker and modified hot blade suffer marginally higher levels of trauma and stress.

While the Bio-Beaker produced the more acceptable end result in terms of appearance of the toe it resulted in an unacceptable level of claw regrowth and could not be recommended to industry.

A further experiment to determine what effect the topical application of an anaesthetic and anti-inflammatory gel had on the feed consumption, live weight and heterophil/lymphocyte ratio of de-clawed emu chicks showed that while de-clawed chicks were slower to commence feeding and were about 10 percent lighter at 2 weeks of age there was no benefit from the application of a the medication. The medication appeared to delay healing and prolong the period of lower feed consumption.

Considerable time was spent attempting to have the Australian Model Code of Practice for the Welfare of Animals - Husbandry of Captive Bred Emus amended to include the de-clawing of emu day old chicks. There was considerable opposition to this within the Sub Committee on Animal Welfare and they subsequently ruled that it should be considered independently by each state.

Skin Grading and Preservation

Unfortunately the planned skin grading and preservation booklet was not produced but material collected for its preparation is availabe for proposed future projects.

Two trials on emu skin preservation were carried out. Results showed that for storage times of less than 6 months commercial sheepskin salt to which 0.5 percent naphthalene had been added gave good results. Skins should not be allowed to dry during storage as any fat adhering to the skin is absorbed as the skin drys. Once absorbed this fat is very difficult to remove during processing and generally results in the discolouration of the leather. Preservation in brine avoided this problem but could not be recommended without further testing.

Implications and Recommendations

This work showed that de-clawing techniques which retain the emus' toe pad under the claw will maximise the development of a pad of tissue at the tip of the de-clawed toe. The development of this pad would appear to protect the tip of the toe against injury from rocks and hard surfaces. A similar result can be achieved using a hot blade de-beaking machine, fitted with a convexed bottom or guide bar and operated to maximise the retention of pad tissue under the claw.

In the absence of a specifically designed machine the de-beaker remains the preferred method of de-clawing emu chicks and it is recommended that people undertaking the procedure should receive instruction on the accepted technique and be familiar with the appearance of a correctly de-clawed toe.

Although industry has subsequently demonstrated that emu chicks can be de-clawed using a more radical cut with mulesing shears this should not be endorsed until the procedure has been fully evaluated and demonstrated to have specific advantages.

The industry should promote the development of a specific de-clawing machine which retains the pad under the chicks toe, uses a hot blade or electric arc to cauterise the wound and reduces the level of operator skill required. This represents the best approach for having the procedure approved by welfare agencies.

The work confirms that de-clawing emu chicks within 24 hours appears to result in a relatively low level of trauma and stress. It increases the time the chicks take to commence feeding by 24 to 36 hours and reduces live weight by about 10 percent at 2 weeks of age. Any live weight depression is recovered by 3 weeks of age.

Skin Preservation

1. For short to medium term storage, commercial sheepskin salt supplemented with a small quantity (0.5%) of naphthalene to repel insects is recommended.

2. All adhering fat be removed from the skins prior to salting.

3. The commercial sheepskin salt should be handled with care since the additives have varying degrees of toxicity.

4. If the skins have been stored for a considerable time (>6 months), have a small selection of the skins tanned and evaluated before going to the expense of having the majority of the skins tanned.

Background to the Project

At the commencement of the project specific legislation to permit the commercial farming and slaughter of emus had been enacted in all states of Australia. Western Australia had been farming for 7 years and its commercial flock had grown to 32,500 birds. Commercial farms were established in Queensland and Tasmania in 1992 and in New South Wales in 1993. While Victoria and South Australia had only just enacted legislation sizeable flocks had existed in South Australia under wildlife legislation since 1991. In total there were 25-30,000 emus of breeding age and 35,000 juveniles being farmed throughout Australia and within three years an annual production of more than 125,000 emus was possible.

Although Western Australia had been selling emu products since 1991 annual slaughtering for product for 1992/93 and 93/94 had been only 5,491 and 5,696 birds respectively and the industry appeared preoccupied with the live bird market. At this level of supply the meat sold well as a low fat, low cholesterol, high protein gourmet meat, emu oil was being sold as a medicinal oil for the relief of joint pain, soft tissue injury and dermatitis and as a base for a range of cosmetics. Body and leg skin was being manufactured into high quality exotic leather but skin damage and subsequent tanning problems had stalled the development of the market and quantities of sub standard skins were being stockpiled.

Scratches from toe nails had been identified as the major cause of skin damage which resulted in average discounts of more than $15 per skin and resulted in very few Grade A skins being produced. Previous research had shown that de-clawing emu chicks immediately after hatch using a hot blade de-beaking machine effectively reduced skin damage and did not result in slower growth rates or higher mortality to slaughter age. The birds appeared to handle more easily and the risk of injury to handlers was greatly reduced.

While the procedure was approved under the Standing Committee on Agriculture and Resource Management Model Code of Practice for the Welfare of Animals - Domestic Poultry it was not an approved management practice under the Model Code of Practice for the Welfare of Animals - Husbandry of Captive Bred Emus. Welfare agencies were requesting research be carried out to identify possible more humane methods of de-clawing and to determine the effectiveness of gas anaesthesia and the topical application of analgesics in reducing the obvious trauma associated with the de-clawing operation. It was apparent that there would be significant opposition from animal welfare groups to the adoption of de-clawing by the industry and it was important to record more information on the procedure.

Part B project objectives included:

- To increase the returns from emu skins by the development of a more humane method of toe trimming.

- To increase returns from emu skins by the introduction of a classification system for skins.

Methods of De-Clawing Emus to Improve the Quality of Emu Leather

Objective

To increase the returns from emu skins by the development of a method of de-clawing emus acceptable to welfare agencies.

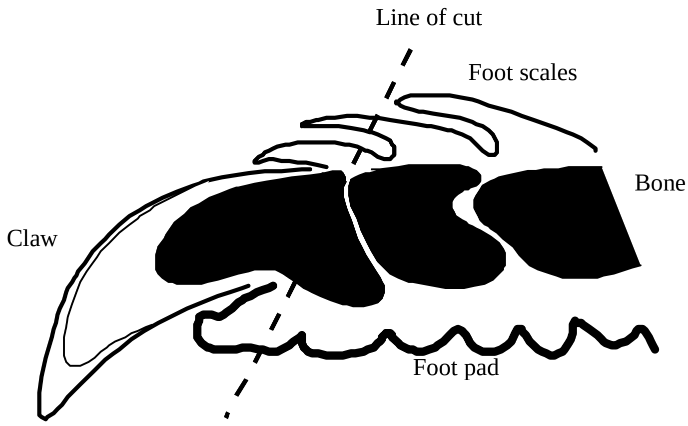
Methodology

The possible use of gas anaesthesia, and a range of alternate techniques for the removal of the claws from recently hatched emu chicks were trialed in a number of small trials. Three of the identified techniques were compared in a larger experiment. A further experiment investigated the use of a topically applied analgesic prior to and following the de-clawing operation. All experiments were subject to the approval of Agriculture Western Australia's Animal Experimentation Ethics Committee.

Gas Anaesthesia of Emu Chicks and the Potential Use of Liquid Nitrogen to Remove Emu Claws

Emu chicks are currently de-clawed by removing the tip of the toe approximately at the last phalangeal joint with a hot blade de-beaking machine (diagram 1).

Diagram 1



Cross Sectional Diagram of an Emu Toe

The end toe pad which extends below the claw is also lost in this operation. In order to prevent unnecessary mutilation of the toe and regrowth of the claw the precision of the operation is critical. Precision is made difficult by the struggling of the chick and the proximity of the hot blade to the operators thumb. The operation is not pleasant and it has raised unfavourable comment from welfare groups.

The use of gas anaesthesia has been promoted as offering the possibility to reduce the trauma of the operation and promote a higher level of precision.

There are alternate methods which could possibly be used to de-claw emu chicks and liquid nitrogen to freeze the blood supply to the nail producing tissue had been suggested as a possibility.

Objectives:

- Determine if mass scale anaesthesia of emu chicks is practical.

- Determine if the application of liquid nitrogen direct to the nail of emu chicks will cause the nail to die and shrivel.

Experimental Methods

Five emu chicks were anaesthetised, using "isofluorane" gas anaesthetic, by an experienced animal anaesthetist, under the supervision of a Senior Veterinarian from the Murdoch School of Veterinary Studies. Liquid nitrogen was applied to the nail of the mid toe of the anaesthetised chicks for periods of up to 15 seconds. A close check on breathing and chick condition was maintained during the procedure and during recovery.

Results

The rate of gas application proved to be critical with a tendency for the chicks to struggle and stop breathing at rates above 2-3 percent . These low application rates meant that it took 3 - 5 minutes to induce anaesthesia in each chick. True anaesthesia appeared to be relatively short but recovery was prolonged with the birds remaining recumbent but sensitive to pain for 15 - 20 minutes.

The application of liquid nitrogen to the intact claw appeared to have limited effect. It became obvious that large volumes of nitrogen and prolonged contact times would be necessary to remove the claw. This would cause considerable damage to surrounding soft tissues with the likelihood of necrosis and slow eventual death of the tissue.

These difficulties, together with the requirement of veterinary supervision and the occupational health problems associated with gas anaesthesia meant that the design of a suitable apparatus for mass anaesthesia of chicks would be complex and the adoption of the procedure would increase the cost of toe trimming considerably. A decision was made to postpone any further work on gas anaesthesia and proceed to further investigate possible methods of removing the claw that could prove to be more humane and appropriate than the current procedure of straight amputation.

Alternate Methods of De-Clawing Emu Chicks - Preliminary Trial

Possible alternate methods which could be used to de-claw emu chicks are:

- the use of a Bio-beaker, which passes a high voltage electric arc through the claw destroying the tissues in close proximity;
- the use of a constricting rubber ring, similar to that used to tail dock lambs, placed firmly around the claw itself and
- the use of a cold blade operated to retain the foot pad under the claw, with and without liquid nitrogen or hot blade cauterisation.

This trial was not allowed to proceed until Xray and microscopic detail of the emu chick's toe were presented to the Animal Experimentation Ethics Committee to provide rational justification of the de-clawing methods proposed. A veterinarian was to be involved in the activity.

Experimental Methods

X-ray and microscopic examination of the emu chick toe was carried out.

The mid toe of 4 chicks were de-clawed by one of the following methods approved by the Animal Experimentation Ethics Committee:

1. Cut Only. The claw cut obliquely with clippers from the point of its attachment to the foot pad to the anterior surface of the toe at the joint of the 3rd and 4th phalanges.

2. Cut and Cauterise. The claw cut as in 1 but the wound cauterised using a hot blade.

3. Cut and Freeze. The claw cut as in 1 but the wound treated with liquid nitrogen.

4. Rings. A rubber ring applied to the claw at its growth point.

5. Bio Beaker. A Bio Beaker™ was used to fire a high voltage arc through the base of the claw.

Chicks were marked to visually identify them to methods of toe clipping, mixed with 9 untreated chicks, and housed in the same pen. They were observed for 30 minutes each day for 4 days after the operation and the activity of each chick recorded. Live weight was recorded each week for 5 weeks and at 12 weeks of age. The condition of the toes of each chick was recorded at each observation and weighing day. One chick from each treatment was sacrificed at 6 weeks of age and the toes examined microscopically. Chicks were retained to 9 months of age to observe any regrowth of the claw.

Results

Observations

1. Cut only.
A standard pair of animal claw trimmers was used for the procedure. The blade passed under the lower surface of the claw and moved through the 4th phalanges to remove the claw at the joint of the 3rd and 4th phalanges. Remnants of the 4th Phalange and the top tip of the 3rd phalange were visible after the procedure. The accuracy of the cut appeared good. The wound oozed rather than bled from the cut bone surface and the periphery of the wound. The animal appeared to suffer no obvious discomfort. This comment was also relevant to treatments 1 - 3. The wound clotted within 30 minutes post operation. The resultant wound was considerably larger than that produced using a hot blade de-beaking machine.

The operation was not permanent and the claws of all 4 birds regenerated totally (8 out of 8).

Diagram 2.

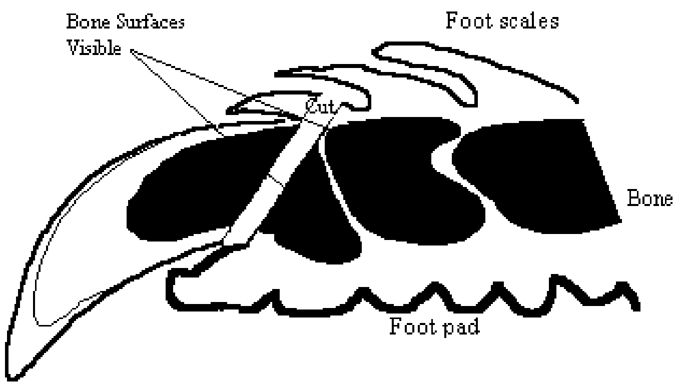


Diagram showing position of cut

2. Cut and Cauterise.
The claw was cut as above (diagram 2.); 2 birds were cauterised for only 1 second using a very hot (cherry red - yellow) blade and 2 birds were cauterised for 3 seconds using a cooler (dull red) blade. Short cautery lacked precision and did not guarantee the total control of bleeding. The longer cautery allowed better precision and bleeding was stopped totally.

Birds cauterised for 3 seconds showed no regrowth of the claw. One bird cauterised for 1 second showed Partial regrowth of 2 claws at 6 weeks of age (2.5 out of 8)

3. Cut and freeze.
The claw was cut as for treatment 1 but 2 birds had the wound frozen with liquid nitrogen and 2 birds had their wound frozen and thawed 3 times. It took 5 seconds to control and develop an acceptable freeze. The procedure was slow and caused an increase rather than a decrease

in the amount of ooze of blood and fluids with half the wounds continuing to ooze for more than 30 minutes.

One bird subjected to the single freezing procedure showed total regrowth of both claws. The other bird of the same treatment showed partial development of one claw at 9 months of age (2.5 out of 8).

4. Rings.
Rubber O rings (internal diameter 0.047 inches, outside diameter 0.07 inches, (Ludowski™ R70002) were applied to the nail hard up against the first scale. The claw horny tissue closer to the scales is soft and the rings migrate to lie hard up against the first scale. The birds showed no obvious discomfort. The claw of these birds took 4 - 6 weeks to shrivel and die. The procedure was not permanent and total regrowth occurred (8 out of 8).

5. Bio Beaker.
The claw was held between the electric contacts and the arc was allowed to flow for about 1 second. The arc burnt a hole through the claw slightly forward of the lower edge of the first scale. The chick appeared to suffer little discomfort from the operation, there was no bleeding and it had an obvious advantage in gaining acceptance by welfare agencies.

The claws of these birds died and began to fall off by 2 weeks of age. One bird showed total regrowth of claws and one claw of one other bird regrew (3 out of 8).

6. Control
10 untreated birds were housed with the treated chicks.

Behaviour
The recording of activity showed no observed differences in behaviour for the 4 days of observation.

Live weight
There were no gross differences in the growth of de-clawed chicks (Table 1).

Table 1

Live weight (g)

Treatment	**Hatch**	**1 Week**	**2 Weeks**	**3 Weeks**	**4 Weeks**	**12 Weeks**
Cut only	420	408	538	734	918	6350
Cut and Heat	408	400	530	768	965	6450
Cut and Freeze	448	438	595	865	1042	5250
O. Rings	436	443	598	852	1073	6500
Bio-Beaker	417	423	565	845	1015	6500
Control	413	392	518	730	860	6050

Microscopic examination

Microscopic examination of the toes of birds sacrificed at 6 weeks of age showed healing to be well advanced with the majority of lesions being covered by a stratified and cornified epithelial layer 5 - 15 cells thick. There was extensive fibrosis of dermis. Poor healing was seen in 3 of the 8 toes examined but is thought to have been associated with bacterial contamination rather than treatment with the poorly healed toes showing focal ulceration and necrosis of epithelium with many bacteria present.

All treatments showed that during the healing process the toe pad was drawn upwards to form a protective pad at the tip. New bone formation and the potential for the toe nail to regenerate was seen in the cut only and cut and cauterise treatments. The O ring treatment showed that only one half of the 4th phalange had become necrotic and the claw was likely to regrow.

Conclusions

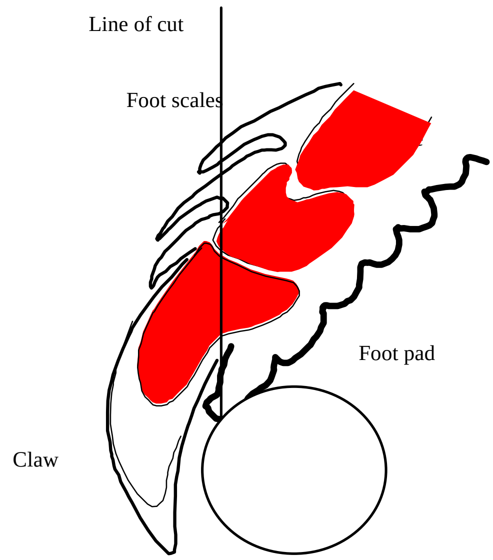
- The O ring treatment was not effective.
- The use of liquid nitrogen as a cautery was not effective.
- The cut only method failed to remove sufficient tissue to prevent regrowth of the claw. It appeared difficult to angle the cut in such a way as to remove all the claw bone and prevent regrowth while retaining the structure of the pad.
- The additional tissue damage caused by the hot blade and liquid nitrogen cautery was generally sufficient to make the operation permanent. This suggested that a slightly more radical cold blade de-clawing technique was a possibility.
- Although the Bio Beaker treatment did result in some re-growth of the claw it was felt that it was possible to modify the machine to increase its effectiveness This procedure was likely to be the most readily accepted by welfare agencies.
- The major finding of the trial was that the retention of the pad under the claw during the de-clawing procedure resulted in the formation of a pad at the end of the emus' toe. This was obviously desirable as it provided a cushion to the end of the toe which produced an increased toe length and a more "normal" looking toe. Further investigation of methods which retained the end toe pad and the possible modification of technique when using the hot blade de-beaker was warranted. The only concern with such methods was the increase in wound area and possible longer healing times which resulted.

Alternate Methods of De-Clawing Emu Chicks - Trial 2

The preliminary trials had demonstrated that the retention of the toe pad under the claw during the de-clawing procedure produced a much more acceptable toe after healing. The toe appeared longer and retained a pad of tissue at its tip which cushioned its contact with the ground. The possibility remained that the increase in the wound size produced by these procedures would cause higher levels of trauma which out weighted this perceived benefit or result in the regrowth of the claw.

Considerable investigation, particularly into the possible use of an electro-cautery wire loop, failed to identify an alternative technique that was likely to achieve a better result than the use of the Bio Beaker, a modified blade fitted to a hot blade de-beaking machine or a hot blade de-beaker fitted with a convexed bottom bar positioned to roll the tip of the emus' toe away from the blade as it was lowered. This increased the slope of the cut and allowed a larger portion of the pad under the claw to be retained. A cold blade method without cauterisation was not included in the study as it was unlikely to be approved by the Animal Experimentation Ethics Committee and appeared to offer little benefit over the methods being tested.

Diagram 3



Modification of technique to maximise the retention of pad tissue

In an attempt to develop a more sensitive measure of the stress caused by de-clawing techniques the number of heterophil and lymphocytes in the blood of de-clawed emus was measured.

An increase in the ratio of circulating heterophils to lymphocytes has been proposed as a sensitive index of chronic stress in the chicken and the procedure should have application to emus (Gross and Siegal, 1988; Jones et al, 1988).

This experiment examined the use of these three techniques for de-clawing emu chicks within 24 hours of hatch.

Objectives

- To compare food consumption, growth and heterophil/lymphocyte ratio of emu chicks de-clawed using a Bio-beaker, a modified hot blade de-beaking machine and a standard hot blade de-beaking machine fitted with a convexed guide bar.

- To compare the precision of these three methods in removing the claws and the amount of end toe pad retained by each.

Experimental Methods

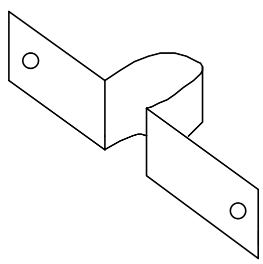
120 emu chicks hatched August 28-30 were individually identified and weighted as they were taken from the hatching trays at 7 am and 2 pm each day. 10 chicks were allocated to one of 12, 4.65 x 1.83 metre pens within an insulated, naturally ventilated chicken brooder house on the basis of weight strata such that all pens contained an equal number of chicks from each strata.

The three treatments:

1.Modified Blade de-beaking machine

The blade was modified to enable the claw to be cut and withdrawn from the end of the toe while retaining the under toe pad.

Diagram 4



Modified Blade

2. *Standard de-beaking machine* and

3. Bio-Beaker

Were blocked for day of hatch and randomly assigned to pens and applied each day. Chicks were housed on clean hardwood sawdust and brooded at 28 degrees Celsius to 4 weeks of age.

Live weight was recorded at hatch, each day for 7 days and at 2, 3 and 4 weeks of age. Feed consumed was recorded daily for 10 days then at 2, 3, and 4 weeks of age.

Stress response studies in poultry show an elevated blood heterophil/lymphocyte ratio in response to stressors and to increasing levels of circulating corticosteroid (Gross W.B. & Siegel H.S., 1983, Jones et al., 1988). A drop of blood was taken from the wing tip of 5 birds from each pen at 14 days of age, placed on a glass slide and blood films prepared without the use of anticoagulant. Films were stained without prior fixation in methanol by the May Grunwald and Giemsa method, and differential white cell counts were performed. Two counts of 100 cells were made, the results averaged and the percentage of each cell type calculated.

Results

Live weight

No differences (P < 0.05) between treatments were recorded for live weight (Table 2). The birds de-clawed using the standard hot blade de-beaker did record a positive weight change on day 5, one day earlier than the other two treatments.

Table 2.

Live weight* (g)

Age	**Modified**	**Hot Blade**	**Biobeaker**	**LSD** (P=0.05)	**Grand mean**	**CV****
Day 0	428	435	433	-	432	2.6
Day 1	414	417	414	4.3	415	2.9
Day 2	400	401	402	6.8	400	2.8
Day 3	385	388	390	7.4	387	2.8
Day 4	379	378	382	6.6	379	3.3
Day 5	374	385	379	15.7	379	4.8
Day 6	378	394	393	22.7	388	5.9
Day 7	392	404	404	20.1	400	4.8
Day 8	415	419	420	14.1	418	3.0
2 weeks	582	608	585	78.5	591	10.6
3 weeks	972	1058	993	154.9	1008	13.4
4 weeks	1430	1566	1468	226.6	1488	12.1

* Treatment means adjusted for live weight at day 0 as a covariate.
** Coefficient of Variation

Feed Consumption

Daily food consumption (Table 3) recorded for the first 9 days was highly variable and only gross changes would have been detected. Cumulative consumption from 0 - 3 weeks and 0 - 4 weeks for the birds de-clawed using the standard de-beaking machine was higher and this approached significance ($P < 0.07$ and $P < 0.11$). This was consistent with the earlier gain and slightly higher live weights recorded for this treatment.

Table 3.

Feed Consumption*
(g/bird/day)

Age	Modified H Blade	Hot Blade	Bio-Beaker	LSD (P=0.05)	Grand mean	CV
Day 1-2	1.58	0.97	1.51	0.69	1.4	68.4
Day 2-3	2.08	1.91	1.93	2.39	2.0	78.0
Day 3-4	5.08	2.84	4.77	3.86	4.2	50.9
Day 4-5	4.74	4.83	6.31	3.82	5.3	42.9
Day 5-6	6.55	7.93	7.58	4.17	7.4	37.0
Day 6-7	14.6	14.60	13.9	7.58	14.4	56.4
Day 7-8	15.2	15.87	14.66	4.11	15.2	42.4
Day 8-9	22.5	27.40	23.9	13.6	24.6	37.3
Week 0-2	30.1	40.90	30.4	14.53	33.8	31.8
Week 0-3**	55.3	69.10	58.5	12.24	61.0	18.1
Week 0-4	75.2	90.00	78.6	14.81	81.3	15.3
Week 2-3	108.3	128.70	116.9	24.4	118.0	15.7
Week 3-4	138.9	154.70	140.8	30.4	144.8	13.5

* Treatment means
** $P < 0.07$

Heterophil/Lymphocyte Ratio

There was no difference between differential leucocyte counts taken at day 14 (Table 4.).

Table 4.

Differential Leucocyte Count (%)

	H	E	B	L	M	H/L
Modified	80.42	0	0	19.40	0.22	4.70
Hot Blade	82.52	0	0	17.32	0.15	5.00
Bio Beaker	81.27	0	0	18.60	0.12	4.68
Grand Mean	81.41	0	0	18.40	0.17	4.80
SD	4.99	0	0	4.96	0.30	1.52
CV	6.13	*	*	26.90	180.40	31.60

H - Heterophil; E - Eosinophil; B - Basophil; L - Lymphocyte; M - Monocyte; H/L - Heterophil/Lymphocyte ratio. SD - Standard Deviation; CV - Coefficient of Variation.

Observations

Regrowth

The condition of the claws of all birds which died or were culled from the trial because of leg problems was recorded. The remainder were examined at 20 weeks of age and the permanency of the operation determined (Table 5). The modified and standard de-beaker treatments gave good precision with the modified blade treatment showing no regrowth of the 240 claws removed and the standard de-beaker regrowth of 6 claws. The Bio-Beaker lacked precision and total or partial regrowth was recorded on 81 of the 240 toes treated (Table 5).

Table 5.

Claw Regrowth and Leg Culls

		Claws Regrown		
Treatment	**Number**	**No of Birds**	**No of Claws**	**Leg Culls**
Modified	40	-	-	8
Hot Blade	40	3	6	6
Bio-Beaker	40	22	81	7

Comparison of the regrowth information and observations taken immediately after the operation showed that to be effective the electric arc needed to pass directly through the claw at its mid point close to the first toe scale. There was a tendency for the arc to hit the horny tissue of the claw and arc over the top of the claw rather than pass directly through or alternatively pass through the lower edge of the claw immediately above the toe pad.

It should be noted that for the Bio-Beaker considerable time was spent modifying the ceramic masks which held the claw in contact with the electrodes to ensure that the electrodes contacted the claw at the desired point. It was necessary to develop a separate mask for each of the 3 claws, side, mid and inner, to achieve an acceptable result.

Leg culls

An unusually high number of birds developed leg problems at 5 to 6 weeks of age and were culled (Table 5). The number of leg culls was not related to treatment but it was observed that this particular hatch of chicks commenced hatch one day early (51 days) and did not show a positive gain in live weigth until day 5-6, a day longer than previous flocks (Table 2). Also 18 of the 24 birds culled for legs took 8 days or longer to regain their original hatch weight. This suggests that chick quality and early nutrition could be important in reducing the incidence of leg culls.

Gross examination

The large mid toes from 8 birds for each treatment were measured and sectioned after slaughter of the birds at 80 weeks of age. No difference in toe length was recorded with the average length of toes for all treatments, measured from the beginning of the first toe scale to the tip of the toe, being 11.6 centimetres (Table). A sample of toes from 8 emus of similar age and weight had an average length of 12.1 cm. While this suggests that de-clawing shortens the toe by less than 1 cm the sample size was small and a larger sample would be necessary to confirm this.

Table 6. **Mid Toe Length* (cm)**

	Control	Modified	Hot Blade	Bio-Beaker
Average	12.1	11.6	11.6	11.7
SD	0.49	0.26	0.50	0.34
Max	13.2	12.0	12.5	12.3
Min	11.3	11.0	11.0	11.2
Number	16	16	16	16

* Measured from first toe scale to tip of toe

Only one successfully de-clawed toe showed the retention of a small portion of the 4th phalange. It would appear that small portions of the 4th phalange not removed by the initial operation were expelled during the healing process. The complete removal of the 4th phalange is necessary to prevent regrowth of the claw.

Almost all toes had a well developed pad protecting the tip of the toe but on average, end toe development was considered to be slightly better for the Bio-Beaker treatment. Poor end pad development was seen only in toes which had a noticeably shortened 3rd phalange.

Discussion

While no difference between treatments ($P < 0.05$) was recorded for live weight and food consumed and heterophil/lymphocyte ratio the fact the birds de-clawed with the hot blade de-beaker showed a positive gain in live weight one day earlier than other treatments and the higher cumulative food consumption recorded by these birds to 3 weeks of age approached significance ($P<0.07$) suggested this treatment caused slightly less stress to the chicks. The application of the modified blade required more contact time with the hot blade and the retention of pad under the claw resulted in a larger wound area. The claws treated with the Bio Beaker took 2 - 3 weeks to shrivel and die and the reaction of chicks when they were touched suggested they remained tender.

The mean differential leucocyte counts of the 14 day old emu chicks showed a high heterophil pool when compared to reference values for domesticated poultry. In the fowl the heterophil pool is high after hatch (>60 - 70%) but by 7 days of age the count may fall to less than 20 % with the predominate cell line being the lymphocyte through to adulthood. Similar high levels of heterophils have been recorded in the ostrich (Robertson G.W. & Maxwell M.H. 1996) and this may be a characteristic of all ratites. The heterophil/lymphocyte ratio did not show that the level of stress caused by the three treatments was different.

Despite considerable time being spent on modifying the “masks” supplied with the Bio-Beaker to improve the precision of the placement of the arc and the development of separate masks to take the large and small claws, a high level of regrowth of claws was recorded. Further development would be needed to make this machine a suitable alternative to the use of the de-beaker. It does have the advantage of being perceived to be less traumatic in its operation and a good pad of tissue develops at the tip of the de-clawed toe.

Conclusion

De-clawing techniques which fully retain the emus’ toe pad under the claw will maximise the development of a pad at the tip of the de-clawed toe. The development of this pad would appear to protect the tip of the toe against injury from rocks and hard surfaces. A similar result can be achieved using a hot blade de-beaking machine, fitted with a convexed bottom or guide bar, operated to maximise the retention of pad tissue under the claw.

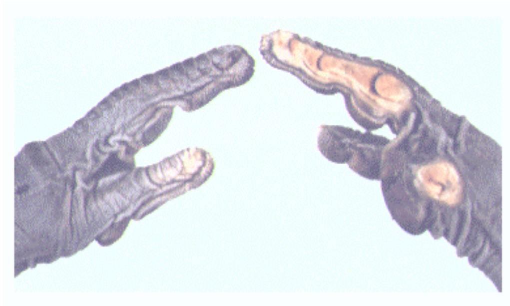
Although techniques which retain the whole of the pad during the operation result in a larger wound and possibly higher levels of stress after the operation they maximise end pad development and the desired result is achieved with a lower level of operator skill. The development of a specific de-clawing machine or blade which retains the toe pad under the claw therefore appears warranted.

In the absence of a specifically designed machine the hot blade de-beaker operated so as to maximise the retention of tissue under the claw, remains the preferred method of de-clawing emu chicks. It is quick, offers a good level of precision and results in the development of a pad at the tip of the de-clawed toe.

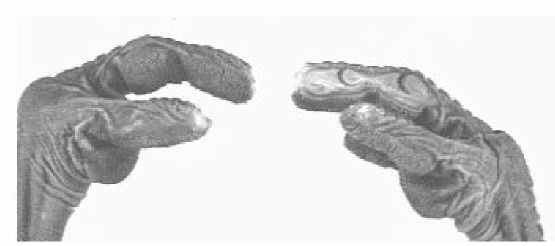
It should be noted that some farmers have trialed the use tail docking devices and mulesing shears for de-clawing emus and while I feel such trials should be strongly condemned the mulesing shears technique was demonstrated to Agriculture Western Australia’s Animal Experimentation Ethics Committee. It did result in a well developed protective pad at the tip of the toe and specific trial work on this technique is recommended.

Diagram 5

De-Clawed feet showing pad development at tip of toe - Modified blade 8 weeks.



Sectioned de-clawed toe showing pad development - Hot blade 6 weeks



Sectioned de-clawed toe showing shortened 3rd phalange and poor pad development - Hot blade 6 weeks

Section through regrown toe - Bio-Beaker™ 6 weeks

Bibliography

Gross, W. B. & Siegel. H. S. (1983). Evaluation of the Heterophil/Lymphocyte Ratio as a Measure of Stress in Chickens. *Avian Diseases* Vol 27 No 4; 972-979.

Jones, Bryan R., Beuving, G., Blokhuis, H. J. (1988). Tonic Immobility and Heterophil/Lymphocyte Responses of the Domestic Fowl to Corticosterone Infusion. *Physiology and Behaviour* Vol 42; 249-253

Robertson, G. W. & Maxwell, M. H. (1996) Differential Counts of Leucocytes and their Fine Structures, Including Thrombocytes, From Day-Old and Adult "African Black" Ostriches. *Poster* presented at Manchester March 1996 - Improving Our Understanding of Ratites In a Farming Environment.

Analgesic Therapy of De-clawed Emu Chicks - Trial 3

While research has shown that de-clawing emu chicks does not result in any long term detrimental effects, de-clawed chicks are slower to commence feeding and weight about 10 percent less than untreated chicks at 2 weeks of age. This suggests that the stress and pain of the operation and subsequent healing of the wound reduces the desire of the chicks to move about and commence feeding.

The topical application of a local anaesthetic gel in combination with an anti inflammatory could potentially reduce the stress and pain of the operation, promote healing and reduce the time de-clawed chicks take to commence feeding (Glatz, P. et al, (1992).

Objective

- To determine what effect the topical application of an anaesthetic gel has on the food consumption, growth and heterophil/lymphocyte ratio of de-clawed emu chicks.

Experimental Methods

120 emu chicks hatched October 10 -12 were individually identified and weighted as they were taken from the hatching trays at 7 am and 2 pm each day. 10 chicks were allocated to one of 12, 4.65 x 1.83 metre pens within an insulated, naturally ventilated chicken brooder house on the basis of weight strata such that all pens contained an equal number of chicks from each strata.

The three treatments:

1. Control - no treatment;

2. De-clawed using a standard de-beaking machine and

3. De-clawed using a standard de-beaking machine with the application of analgesic before and after the procedure.

were blocked for day of hatch, randomly assigned to pens and applied within 2 hours of the chicks being removed from the hatch trays. Chicks were housed on clean hardwood sawdust and brooded at 28 degrees Celsius to 4 weeks of age.
A liberal coating of a mixture of local anaesthetic (200 mg/g lignocaine hydrochloride) and an anti-inflammatory (50 mg/g phenylbutazone) mixed with a penetrating agent (200 mg/g dimethyl sulphoxide) was applied to all toes using a soft pad at least 10 minutes before and again immediately after de-clawing.

Live weight was recorded at hatch, each day for 7 days and at 2, 3 and 4 weeks of age. Feed consumed was recorded daily for 10 days then at 2, 3, and 4 weeks of age.

A drop of blood was taken from the wing tip of each bird immediately prior to the application of treatments and again on day 3 after treatment, placed on a glass slide and blood films prepared without the use of anticoagulant. Films were stained without prior fixation in methanol by the May Grunwald and Giemsa method, and differential white cell counts were performed. Two counts of 100 cells were made, the results averaged and the percentage of each cell type calculated.

Results

Live weight

The average live weight recorded from 4 days to 2 weeks of age for de-clawed birds was 5 - 10 percent lighter than the controls ($p<0.05$). The de-clawed birds given no analgesic treatment recovered from this live weight depression by 3 weeks of age. The treated birds were still lighter at 4 weeks of age ($P<0.07$) (Table 7).

Table 7.

Live weight*
(g)

Age	Control	Hot Blade	Hot Blade + analgesic	LSD (P=0.05)	Grand mean	CV**
Day 0	423	417	416		418	0.8
Day 1	404	402	402	5.5	403	0.6
Day 2	390	389	388	6.0	389	0.7
Day 3	384	378	376	6.8	379	0.8
Day 4	399**a*****	380**b**	373**b**	18.0	384	2.1
Day 5	419	394	386	28.2	400	3.2
Day 6	444**a**	411**b**	400**b**	22.8	418	2.4
Day 7	464**a**	430**b**	415**b**	25.8	436	4.9
2 weeks	768**a**	694**b**	649**b**	61.9	704	3.9
3 weeks	1217**a**	1200**a**	1109**b**	53.3	1175	2.0
4 weeks	1728**a**	1708**a**	1596**b**^	127.9	1678	3.4

*   Treatment means adjusted for live weight at day 0 as a covariate.
**   Coefficient of Variation %
*** Treatment means in each row followed by a different subscript are significantly different ($P<0.05$).
^   ($P<0.07$)

Feed consumption
De-clawed birds ate less feed than control birds from 3 days to 2 weeks of age. De-clawed birds treated with an analgesic continued to eat less feed than the controls and the untreated de-clawed birds until 3 weeks of age (Table 8).

Table 8.

Feed Consumption*
(g/bird/day)

Age	**Control**	**Hot Blade**	**Hot Blade + Analgesic**	**LSD** (P<0.05)	**Grand mean**	**CV**
Day 1-2	0.6	0.7	0.3	0.6	0.53	66.6
Day 2-3	2.6	1.2	1.2	1.7	1.67	60.9
Day 3-4	6.7**a****	3.1**b**	3.0**b**	3.2	4.27	45.4
Day 4-5	10.7**a**	6.1**b**	5.7**b**	2.7	7.50	21.7
Day 5-6	18.5**a**	12.7**a**	10.4**b**	6.6	13.8	28.5
Day 6-7	25.9**a**	20.0**b**	16.8**b**	5.8	20.9	16.7
Day 7-8	40.7**a**	28.6**b**	24.6**b**	9.1	31.3	17.4
Day 8-9	54.7**a**	38.2**b**	32.6**b**	10.8	41.8	15.4
Week 0-2	47.7**a**	39.3**b**	34.7**c**	4.6	40.6	6.7
Week 0-3**	81.1**a**	76.0**b**	66.5**c**	3.4	74.6	2.8
Week 0-4	104.9**a**	101.8**a**	90.7**b**	5.1	99.1	3.1
Week 2-3	149.3**a**	151.3**a**	131.6**b**	9.8	144.1	4.1
Week 3-4	177.4	180.1	164.7	14.5	174.1	5.0

* Treatment means
** Treatment means in each row followed by a different subscript are significantly different (P<0.05)

Heterophil/Lymphocyte ratio
The differential leucocyte counts of the birds which were treated with the analgesic where different to the other groups prior to the application of treatments (Table 9). This cannot be explained and makes interpretation of the measurements taken on day 3 difficult.

Counts taken three days after treatment and adjusted using day 1 counts as a covariate (Table 10) showed that the de-clawed birds not treated with an analgaesic had maintained a higher level of circulating heterophyls than the control birds and this is consistent with a higher level of Stress. Blood analysis did not differentiate between the level of stress experienced by the de-clawed treatments and the de-clawed treatment treated with analgaesic and the control (Table 9).

De-clawed birds did show a smaller reduction in heterophyl/lymphocyte ratio over the 3 days (Table 9) and again this is indicative of a higher level of stress.

Table 9.

Differential Leucocyte Count (%) Day 1**

	H	E	B	L	M	H/L	%Ch
Control	93.15**a***	0	0	6.55**a**	0.30	15.81**a**	64.67**a**
Hot Blade	92.94**a**	0	0	6.87**a**	0.21	15.92**a**	55.95**b**
HB + Anlgsic	89.50**b**	0	0	10.41**b**	0.21	9.81**b**	45.10**c**
Grand Mean	91.86	0	0	7.95	0.24	13.84	55.24
SD	3.74	0	0	3.78	0.36	6.01	21.82
CV	4.07			47.50	149.30	43.38	39.50

* Means in columns followed by a different subscript are significantly different (P<0.05). ** Treatment Means
H - Heterophil; E - Eosinophil; B - Basophil; L - Lymphocyte; M - Monocyte; H/L - Heterophil/Lymphocyte ratio; SD - Standard Deviation; CV - Coefficient of Variation. %Ch - Percentage change of H/L, day1 to day3.

Table 10.

Differential Leucocyte Count (%) Day 3 **

	H	E	B	L	M	H/L
Control	81.58**a***	0	0	18.23**a**	0.21	4.84**a**
Hot Blade	84.01**b**	0	0	15.84**b**	0.21	6.19**b**
HB + Anlgsic	82.72**ab**	0	0	17.09**ab**	0.15	5.39**ab**
Grand Mean	82.77	0	0	17.05	0.19	5.47
SD	4.87	0	0	4.86	0.36	2.45
CV	5.89	*	*	28.53	185.80	44.76

* Means in columns followed by a different subscript are significantly different (P<0.05). ** Treatment Means -adjusted for covatiate.
H - Heterophil; E - Eosinophil; B - Basophil; L - Lymphocyte; M - Monocyte; H/L - Heterophil/Lymphocyte ratio. SD - Standard Deviation; CV - Coefficient of Variation ;

Discussion

This trial is consistent with previous work which showed that de-clawing at hatch will depress live weight by about 10 percent for the first 2 weeks of life. This loss of live weight is regained by 3 weeks of age. However, birds treated with an analgesic prior to and immediately after the operation were still lighter at 4 weeks of age and it would appear that the analgesic prolonged healing.

This lower live weight is the direct result of de-clawed birds being slower to commence feeding and recording a lower level of feed consumption for the first 2 weeks after hatch. The application of the medication prolonged the period of lower feed consumption. It has been reported that anti-inflammatory dugs can interfere with the healing of wounds and this is thought to have delayed healing sufficiently in the first few days to effect feed consumption.

Heterophil/lymphocyte ratio measurements did show that de-clawed birds maintained a higher level of circulating heterophils and this is consistant with higher levels of stress. However, blood analysis did not differentiate between the level of stress experienced by the de-clawed birds and the de-clawed birds treated with analgaesic and the control and did not show a benefit for the topical application of an analgesic/anti-inflammatory drug.

Conclusion

This trial supported previous work which showed that de-clawing emu chicks at hatch using a hot-blade de-beaking machine delayed the time chicks commenced to feed and caused a 10 percent depression in live weight for the first 2 weeks of life. This effect was compensated for by 3 weeks of age.

Live weight, feed consumption and the heterophil/lymphocyte ratio, as a measure of stress, failed to show a benefit for the topical application of an analgesic/anti-inflammatory drug.

The application of medication containing an analgesic and anti-inflammatory drug prolonged the period of live weight depression recorded for de-clawed emu chicks.

Research to develop techniques which minimise the stress of de-clawing would benefit from the development of a sensitive objective measurement of the level of pain and stress associated with alternative de-clawing procedures.

Industry Practice

During the course of this research the Agency liaised extensively with its Animal Experimentation and Ethics Committee and the Royal Society for the Prevention of Cruelty to Animals (RSPCA). While the RSPCA did not support the procedure they would not prosecute farmers de-clawing day old emu chicks provided correct procedures were used.

The Agency developed a recommended procedure (Appendix 1.)and this was supplied on request after consultation with farmers wishing to perform the procedure. It also became clear that without action to standardise the procedure there was a real risk of farmers experimenting with unacceptable techniques. With industry support an effort was therefore made to amend the Australian Model Code of Practice for the Welfare of Animals - Husbandry of Captive Bred Emus to provide for the de-clawing of day old emu chicks (Appendix 2.).

There was considerable opposition to de-clawing emus within the Sub Committee on Animal Welfare and it was considered that limiting initial approval to the use of a hot blade debeaking machine would increase the prospect of it being approved. The technique is quick, has a high level of precision, had been demonstrated to Sub Committee Members and was supported by the results of our research.

Despite strong industry support and a survey in 1996 which showed that almost all emus reared in Western Australia, 40 - 50 percent in Victoria, New South Wales and South Australia and 20 percent in Queensland were being de-clawed the Sub Committee on Animal Welfare failed to reach agreement on the proposed amendment and agreed that each State be free to consider the issue independently.

Some committee members saw de-clawing as a “quick fix” which would remove any motivation for the industry to reseach alternate methods of preventing the problems presented by sharp claws and saw a potential for adverse affect on domestic and export markets from negative publicity about the practice.

Bibliography

Glatz, P. C., Murphy, L. B., Preston, A. P.. (1992) Analgesic therapy of beak trimmed chickens. *Australian Veterinary Journal*, Vol 69. No 1, January 1992.

Skin Description System

The industry does not have a standard skin description system and skins are sold per piece on the basis of a subjective grade. An objective of the project was to develop an objective skin grading system based on effective cutting area in conjunction with Tanners and Leather product manufacturers in Australia. This would remove the uncertainty buyers face with the current system, improve marketing and ensure payment for quality.

It had been planned to produce a colour booklet featuring photographic standards and recommended procedures for skin preservation.

Two trials on the preservation of the skins were completed. A lighted dome which enabled clear viewing and area measurement of emu skins was built and 120 skins collected and photographed. It had been planned to circulate these photograhs to interested tanners for their grading and comment. The grades and comment were to be pooled and selected skins in each grade tanned for final evaluation and photographs.

Difficulty was experienced in finding sufficient tanners to participate in the grade assessment of the skins and the expertise of local tanners with experience in tanning emu skins was lost to the project. The planned booklet was therefore not completed but the material is available for proposed future RIRDC projects on exotic skins.

Emu Skin Preservation

The main problem with preserved commercial emu skins seen by tanners is the inconsistency in the preservation with some lots from the same supplier showing red heat were others were not. The reason for the inconsistency was unknown but many producers were preparing there own preservation mixtures using the recommendations of the tanner which were for a mixture of 1% boric acid, 1% naphthalene and 98% salt (sodium chloride). Failure to uniformly mix the boric acid and naphthalene through the salt may contribute to the inconsistent preservation observed. Furthermore, the grade of salt was not specified and not all grades are suitable for skin preservation.

Mixtures for the preservation of sheep skins and cattle hides are commercially available and are widely used. The mixture used for sheep skins is composed of 1% sodium fluoride, 1% boric acid and the remaining 98% is a medium coarse salt. For cattle hides the mixture is 1% boric acid, 1% naphthalene and the remaining 98% is a very coarse salt. The salt used in the sheep mixture was considered suitable for use with emu skins but that used in the hide mixture was considered too coarse for use with emu skins.

The present study compares a variety of preservation procedures including salting with salt alone, the commercial sheep skin mixture and a mixture containing the same chemicals a the commercial hide mixture but using a finer grade salt (casing salt). Also, a wet brine mixture was used as well as freezing. In addition to the quality of the leather produced, objective measurements of any changes in the properties of the collagen during storage were made.

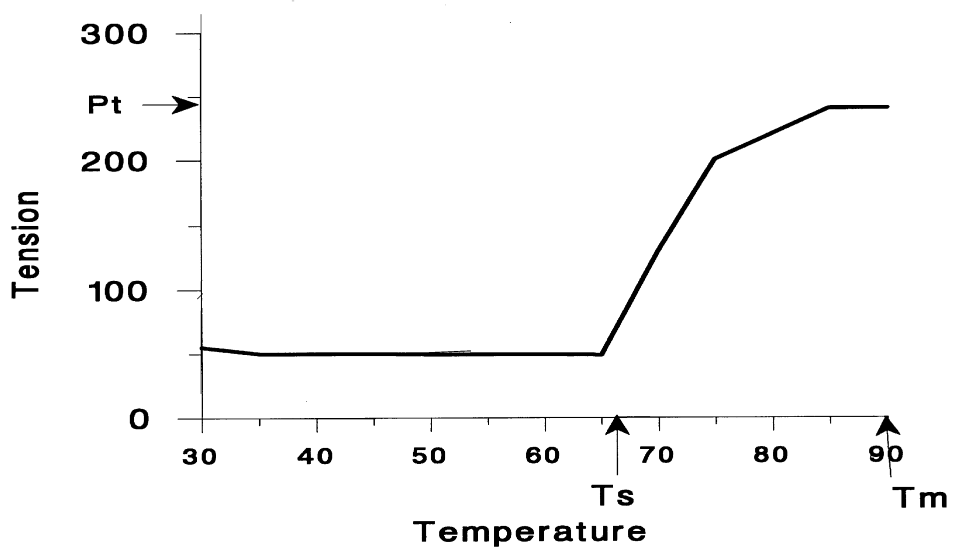
Methodology

For the first trial twelve unselected skins were obtained from the abattoir. There was extensive bruising and scratches on all skins. Six skins were graded as having no commercial value, two as E grade, two as D grade and two C grade. Two of the skins were frozen, two were treated with salt alone (casings grade), two with the commercial sheep skin mixture, two with a mixture of 1% boric acid, 1% naphthalene and 98% casing salt and two were placed in a brine mixture composed of 20% (w/v) salt, 0.01M acetic acid and 500 ppm sodium metabisulphite and the pH adjusted to 4.4 with NaOH. The skins were covered loosely with plastic and left at ambient temperature except for the frozen skins.

The skins were assessed visually after 4 weeks storage. After 8 weeks the skins were inspected and samples taken to measure the shrinkage behaviour of the skins. To measure the shrinkage behaviours, samples of the skins were washed with water for 90 minutes and the equilibrated in 0.2M sodium acetate overnight. The next day the samples were heated in 0.2M sodium acetate and the tension generated by the samples versus temperature profiles recorded and the shrinkage temperature (Ts), the temperature at which the peak tension occurred (Tm) and the peak tension (Pt) determined (Diagram 1). A decrease in any of the values is indicative of the deterioration of the collagen present. After 16 weeks storage the above procedure was repeated and the skins discarded.

Diagram 1.

Plot of temperature versus tension
for heated emu skin samples



For the second trial, skins from 8 of the Departments birds were used to minimise physical damage (scratches and bruises) to the skins. Two of the skins were treated with salt alone (casings grade), two with the commercial sheep skin mixture, two with a mixture of 1% boric acid, 1% naphthalene and 98% casing salt and two were placed in a brine mixture composed of 5L of water, 1 kg of salt, 4% sodium acetate and 5g of sodium metabisulphite and the pH adjusted to 4.2. The skins were covered loosely with plastic and left at ambient temperature. After 3 months storage the skins were assessed and sent for tanning.

Results

Trial 1

After 4 weeks storage, the skins preserved with salt alone were white and appeared to be in reasonable condition. There was no obvious smell or signs of deterioration and the skins were reasonably moist. The skins preserved with the commercial sheep skin mixture were in a similar condition. The skins preserved with salt plus 1%boric acid and 1% naphthalene did not appear to be in as good condition as the other salted skins. There was some discolouration (brown-red) of the skins which was probably due to blood from the scratches. The frozen skins had gone a red brown colour all over. After 4 weeks there was a lot of scum on the surface of the brine, which appeared to be a mixture of fat and mould. After a brief wash with detergent the skins seemed fine and basically looked like fresh skins. Prior to washing the slush preserved skins were smelly.

After 8 weeks storage, visually there was no obvious differences between the wetted back samples but those which had boric acid in the mixture appeared to be browner than the other salted skins particularly in the feather holes. Apart from the smell and scum, the brined skins look the best.

The results of the shrinkage tests are summarised in Table 1.

Table 1

Ts, Tm and Peak Tension of Heated Emu Skin after 8 weeks preservation

Preservative	Ts	Tm	Peak tension (kg/cm^2)
Salt alone.	65.0	89.5	3.9
Salt+boric acid and naphthalene.	65.5	89.0	2.8
Sheep skin mixture.	66.0	91.0	3.3
Brine	65.5	90.0	3.5
Frozen	66.0	90.5	3.7

It is noted that the two samples that have boric acid in the salt have the lowest peak tensions but the differences are probably not significant.

After 16 weeks storage, parts of the skins preserved with salt alone were quite dry and where they have dried out the skin had taken on a distinct yellow colour. The skins appear to be in reasonable condition. There was no obvious smell or signs of deterioration. The skins preserved with the commercial sheep skin mixture were a creamy yellow colour and quite dried out. The skins preserved with salt plus 1%boric acid and 1% naphthalene had dried out in a number of areas and were quite discoloured. The frozen skins had a red brown colour all over. The main feature of the skins preserved in the brine was that the epidermis was coming off in sheets. The brine was still a bright red colour and smelt as before, but no worse. After a brief wash with detergent the skins were fine and basically looked like fresh skins.

After wetting back overnight, all skins seemed acceptable, apart from the initial damage. The brined skins looked the best. With the salted skins the epidermis appears to be breaking down, this was most advanced with the naphthalene/boric acid treated skin. The frozen skin was a pink colour and the bruising was very easy to see.

The results of the shrinkage measurements are summarised in Table 2.

Table 2

Ts, Tm and Peak Tension of Heated Emu Skin after 16 weeks preservation

Preservative	Ts	Tm	Peak tension (kg/cm^2)
Salt alone.	67.5	91	4.1
Salt+boric acid and naphthalene.	66.5	90	4.1
Sheep skin mixture.	66	90	4.3
Brine	66	88	3.7
Frozen	66	90	2.0

The low value of the peak tension obtained with the frozen sample is surprising and suggests that there is some break down of the collagen. A repeat sample was tested and a similar result was obtained.

It was not considered to be of any value to have these skins tanned because of the extent of damage (bruises and scratches) on these skins.

Trial 2

After 3 months storage, the various salted skins had dried out somewhat but there were no obvious differences between the different salt preparations. The epidermis was coming off the brined skins but otherwise they seemed in excellent condition with no signs of putrefaction. The skins were taken to the tanner for his assessment prior to and after tanning. None of the preserved skins showed signs of red heat or any other microbial damage.

There were no obvious differences between the leather produced from the skins preserved with the various salt preparations.

Discussion

In these trials, the salt alone appeared to be as effective preservative as the salt mixtures containing additives. However, these trials were performed at a time of the year (spring) when temperatures were moderate and there was limited insect activity. Salting without additives is not recommended. All additives having varying degrees of toxicity and should be handled with care. For cost effectiveness and simplicity the use of commercial sheepskins salt supplemented with a small quantity (0.5%) of naphthalene is recommended.

This form of salting (wet salting) is only suitable for short to medium (< 6 months) preservation and not long term preservation. The skins will show slow deterioration with this form of preservation and so if skins have been preserved for a considerable time (>6 months) it would be wise to have a small selection of skins tanned and evaluated before going to the expense of having the majority of the skins tanned.

Prior to salting, the adhering fat should be removed because as the skins dry out the fat (oil) becomes absorbed into the skins. Once absorbed this fat is very difficult to remove during processing and generally results in the discolouration of the leather. The brine solutions were tried as method to avoid drying off the skin but the leather prepared from one of the skins that had been preserved in brine was showing signs of grain break. Whilst this may not be due to preservation, the use of brine is not recommended without further testing.

Recommendations

1. For short to medium term storage, commercial sheepskin salt supplemented with a small quantity (0.5%) of naphthalene to repel insects is recommended.

2. All adhering fat be removed from the skins prior to salting.

3. The commercial sheepskin salt should be handled with care since the additives have varying degrees of toxicity.

4. If the skins have been stored for a considerable time (>6 months), have a small selection of the skins tanned and evaluated before going to the expense of having the majority of the skins tanned.

Appendix 1

DE-CLAWING EMU CHICKS

Peter O'Malley
Agriculture Western Australia

Background

Emus grown commercially in large flocks can suffer serious trauma from cuts and scratches caused by the claws of their pen mates during displays of natural aggression, social interaction and transport . In addition some birds are difficult to handle and the claws can inflict serious injury to anyone handling the birds.

De-clawing (toe trimming), which involves removing the toe nail and its growth point, is a recognised procedure in the poultry industry and is approved under the SCA Code of Practice for the Husbandry of Poultry. While de-clawing emus has welfare implications, if done soon after hatching it is unlikely to have a major impact on the growth and welfare of the bird but will result in significantly less damage to the birds and their skin from fighting and during transport. It will also significantly reduce the risk of injury to people handling emus.

A trial to determine the effect of de-clawing on the feed consumption, growth and skin quality of emus was completed by the Department of Agriculture Western Australia in 1993. De-clawing emu chicks at hatching depressed feed consumption during the first few weeks of life and reduced liveweight by about 10 percent at 2 weeks of age. There was no significant effect on growth beyond this age. No difference in mobility was observed, fighting was reduced, the birds were easier to handle and there was no effect on mortality.
As the birds reached maturity there was a tendency for the de-clawed birds to eat less feed and the cumulative feed eaten over the total period of the trial reached significant differences at 44 weeks of age. While the lower feed consumption resulted in a $3 - $4 saving in feed the reason for it was not determined.

The quality of skins collected from the de-clawed birds was dramatically improved with 72 percent of skins being graded as A or B grade compared to 35 percent for untreated controls. There was no effect on the amount of muscle and fat recovered at slaughter.

Welfare considerations

While the procedure is simple it is unlikely to be accepted by animal welfare agencies unless it is performed with a high level of precision according to the following conditions.

(1) Chicks must be de-clawed as soon after hatching as possible, preferable within 24 hours and no later than 36 hours.

(2) A hot blade chick de-beaking machine must be used.

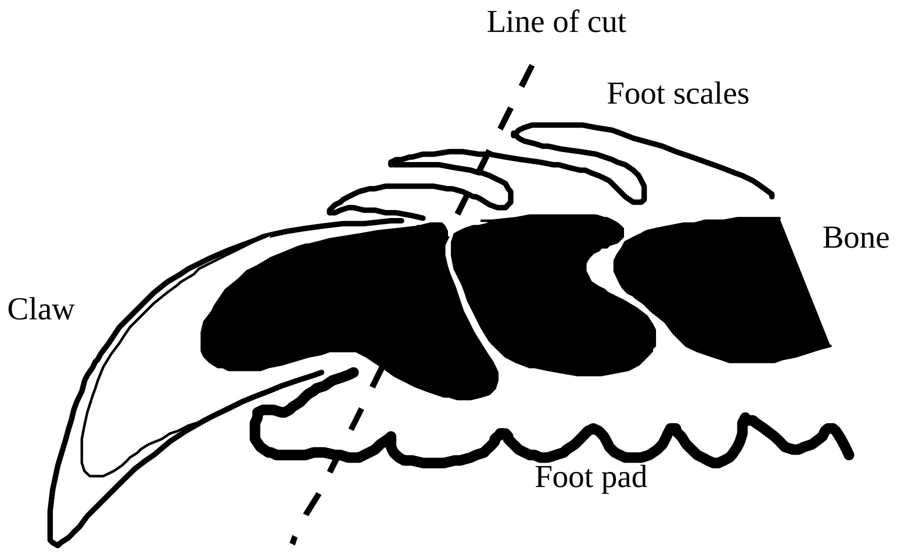
(3) De-clawed chicks must be housed on clean litter, rubber matting or similar soft material.

(4) The operator will be expected to demonstrate a high level of skill and precision when performing the procedure. As a minimum he will have a detailed knowledge of of the contents of this leaflet and have received instruction from a person experienced in the operation.

(5) The operation must be performed according to the following procedure.

Recommended procedure for de-clawing emu chicks

Diagram of a microscope slide section of an Emu's toe.



To remove the nail and its growth point aim for the centre of the second scale behind the claw. The first scale is closely adhered to the nail while the second appears to be more loosely attached to the skin of the toe. Attempt to slope the cut toward the end of the toe so as to retain as much of the foot pad as possible. This can be achieved by adjusting the convexed lower rest bar in a more foreward position so that the cutting bar contacts its inner edge. To achieve a good result the operators thumb must be held closely to the hot blade of the de-beaking machine and should be protected with a woollen guard.

Procedure

1. De-claw chicks as soon after hatching as possible and definitely within 36 hours. Younger chicks are easier to de-claw and bleed less.

2. Turn the heat setting of the blade to med-high. A bright red blade with a touch of yellow (when shaded from direct light) appears to work best but for good cauterization you need to achieve a balance between blade temperature and time.

3. Grasp the chick's toe with the thumb and first finger, as close to the claw as practical and attempt to draw the skin and tissue away from the tip of the toe. This should result in a

minimum of soft tissue being removed and avoid leaving raw bone exposed after the operation.

4. Place the chick's toe on the lower rest bar and, while holding the thumb as close to the cutting blade as possible, lower the cutting bar with the foot pedal. Aim for the middle of the second scale behind the nail. Avoid sloping the cut in the wrong direction ie. the cut should be angled to leave the sole of the toe longer than the top surface. The chick will react to the heat of the blade and a degree of skill, dexterity and speed is required to carry out the procedure correctly. The small inside toes are the most difficult to treat. Check that the remaining 2 toes are below the rest bar before you operate the foot pedal. Inexperienced operators should practice manipulating the toes of the chicks and operating the foot pedal with the blade removed and the machine off before attempting the procedure for the first time. You may find it easier to commence with the outside toe of the left foot and treat each toe in order from left to right.

5. Minor bleeding from cut toes can be expected. Older chicks will bleed more but bleeding should stop within a few minutes.

6. Maintain a check on technique and take time every half hour to examining the claws that have been removed. Failure to remove even a small portion of the growth point of the horny tissue covering the claw will result in regrowth.

7 De-clawed chicks should be placed under the brooders on clean hardwood sawdust or soft rubber matting. Infection is not a problem and the Department has recorded only one chick with a swollen toe following the operation. Chicks should not be housed on wire, concrete or other hard surfaces.

8. De clawed chicks are slower to commence feeding and care should be taken with the placement of waterers and scratch trays.

Appendix 2

Sub Committee on Animal Welfare

AMENDMENT OF THE
CODE OF PRACTICE - HUSBANDRY OF CAPTIVE BRED EMUS

Purpose

To seek amendment of the Australian Model Code of Practice for the Welfare of Animals - Husbandry of Captive Bred Emus to provide for toe trimming day old emu chicks.

Background

Commercial experience has demonstrated that emus can suffer serious trauma from cuts and scratches when struck by the claws of their pen mates during displays of natural aggression, social interaction and transport. Aggressive behaviour is first seen at 40 - 50 weeks of age as the birds reach a certain stage of physiological maturity and occurs again after 60 - 70 weeks of age as the birds commence to establish mating bonds. Individual birds which are difficult to handle can inflict serious injury on their pen mates and operators when being driven in a group, sexed, weighed or transported.

Research conducted by Agriculture Western Australia has demonstrated that de-clawing emu chicks at hatch by removing the tip of the toe approximately at the last phalangeal joint with a hot blade de-beaking machine dramatically reduced damage to the birds and their skin from fighting and transport. The risk of injury to people handling the birds was also greatly reduced. The operation did however, depress feed consumption during the first few weeks of life and liveweight at 2 weeks of age was about 10 percent lower. There was no significant effect on growth beyond this age. No difference in mobility was observed, fighting was reduced, the birds were easier to handle and there was no effect on mortality.

No evidence of traumatic neuromas, abnormal tangles of regenerative nerve fibres that can spontaneously discharge and cause chronic pain in amputated limbs, was found in 3 toes analysed by a neuro scientist.

The quality of skins collected from the de-clawed birds was dramatically improved with 72 percent of the skins being graded A or B grade compared to 35 percent for untreated controls. There was no effect on the amount of muscle and fat recovered at slaughter.

Issues

While de-clawing emus has welfare implications, if done soon after hatch it has no major impact on growth and welfare of the bird but will result in significantly less damage to the birds and their skins from fighting and during transport. It will also significantly reduce the risk of injury to people handling emus.

The emu industry is keen to adopt de-clawing as a standard husbandry technique and a national consensus on the acceptability of the practice is needed.

Any delay in making this decision increases the risk of farmers experimenting with unacceptable techniques.

Consideration

It is proposed that the Code should be amended and a new clause added under the heading of Hatchery Management, after the existing clause 8.3. The new section would read as follows, or contain words to carry the following meaning.

> "8.4.1 To avoid claw injury to farmed emus the tip of each toe may be removed, approximately at the last phalangeal joint, soon after hatch using a hot blade de-beaking machine.
>
> 8.4.2 The de-clawing procedure shall be carried out by a competent operator with strict adherence to the procedures published by the......
>
> 8.4.3 The claws shall not be removed from chicks more than 36 hours old and no other methods of claw removal are permissible, unless research undertaken provides demonstrable welfare benefits."

Recommendation

That members of the Sub Committee endorse a proposal to amend the Code to provide guidelines for toe trimming day old emu chicks.

Part C
Emu Oil

By Peter O'Malley
and John M. Snowden

Agriculture Western Australia

CONTENTS

Executive Summary

An initial objective of the project was to increase returns from emu oil by identifying dietary and/or management, seasonal factors which influence the level of the active anti inflammatory component of emu oil. Achievement of this objective depended on the claim made by Emu Products Western Australia Pty. Ltd., a Western Australian Company which had registered patents on the use of emu oil, that they were able to determine the level of active ingredient contained in emu oil samples. Researchers working in the area were confident that diet would influence the level found in the fat.

It was subsequently found that the active ingredient had not been identified and an easy method of determining the therapeutic efficacy of oil samples did not exist.

As it was felt that the future profitability of the industry would be largely dependent on being able to sell emu oil at relatively high prices based on its therapeutic value additional money was granted to the project to research existing emu oil patents, assess their effect on future oil research, demonstrate the efficacy of emu oil within existing anti-inflammatory models and to evaluate rat models and other biological and chemical analysis as a means of demonstrating efficacy within emu oil samples.

A meeting of industry representatives and researchers with expertise and interest in emu oil research proposed a plan for a national emu oil research and development program to be funded by RIRDC. This subsequently led to the funding of two emu oil research projects undertaken by Agriculture Western Australia. Copies of the American Patents granted to Emu Products Western Australia Pty. Ltd. New World Technology Incorporated. were obtained and made available to industry.

Patents for pure and mixtures of emu oil applied in the USA but the Emu Products Patent in Australia had been challenged and did not apply. There was the opportunity however, for the company to respond to the challenge at any time in the future.

Information in the patents did not provide conclusive proof of the anti-inflammatory property of emu oil and demonstrated that samples varied in their efficacy. Much of the data on its efficacy a& the active components of the oil was not available publicly and was contradictory. It was concluded that suitable models to quantify the penetrating properties of emu oil and its efficacy in the reduction of oedema should be developed and further legal advice sou ght after the efficacy of emu oil had been clearly established and factors contributing to the production of efficacious oil determined.

An extensive review of the literature determined that the polyarthritic and carageenan rat models were the most appropriate to demonstrate that emu oil did exhibit anti-inflammatory activity. Cellular models to determine the mode of action of emu oil at the cellular level could be of value at a later date.

Initial work centred on developing repeatability and confidence in the Carageenan model as a bio-assay for determining anti-inflammatory activity.

Collaborative work with Dr M. Whitehouse using the adjuvant induced polyarthritic rat model was commenced and samples of oil known to give different levels of efficacy within that model were submitted to the University of Queensland for chemical analysis.

Samples of oil from Mt Romance were tested for a "pilot" Short Term Irritancy and Anti Inflammatory Activity by Australian Photobiological Testing Facility Pty. Ltd. While emu oil showed no adverse irritancy to the six subjects tested the result is limited by the small number of subjects. The Inflammatory Activity test proved inconclusive.

At the request of industry a 'generic' emu oil promotional brochure, "The 'Good Oil' on Emu Oil," was produced to the initial proof stage. Subsequent discussions with the Therapeutic Drugs Administration on the suitability of the leaflet for the promotion of products containing emu oil caused its printing to be postponed.

Background

At the commencement of this study high prices were being paid for emu oil for the manufacture of therapeutic and cosmetic products because it was believed to have therapeutic properties. Typical claims of being made were:

"Enriched by oleic and linoleic fatty acids, emu oil exhibits anti-inflanimatory effects on skin. It penetrates the skin deeply and quickly, it can help provide fast temporary relief from soreness, leg cramps, and other types of muscle aches, pains and pulls.

Emu oil offers quick relief from insect bites and stings, cuts, scrapes and bruises, bums and sunbums, chapped lips and other minor skin irritations. Use it for poison Ivy, diaper rash, warts, haemorrhoids, blemishes, scars, stretch marks, hair care, and as a skin soothing after-shave.

Rich in essential fatty acids, emu oil is an excellent skin hydrating product. It helps to promote natural healing, rejuvenate dry skin, and freshen skin tissue, leading to soft supple skin. Continued use will help to "plump" up skin's underlying layer and some say, reduce the appearance of fine lines."

A United States Patent had been granted for an anti-inflammatory composition derived from emu oil to Emu Products Western Australia Pty Ltd., and a United States Patent for pure emu oil for wide ranging therapeutic applications granted to New World Technology Incorporated, John Caputo,

Despite this emu oil was not registered under the Therapeutic Goods Act and no therapeutic claims for its use could be made.

The development of a viable emu oil industry was considered critical to the success of the emu industry in Australia and the industry recognised that prices for the oil could drop rapidly unless high value end uses for it could be guaranteed. This was unlikely to be achieved without scientific backing for the claims being made and registration under the Therapeutic Goods Act. Industry requested assistance from RIRDC to determine the level of information already available and the formulation of a Research and Development Program to demonstrate the therapeutic properties of the oil. The ultimate aim was to gain registration for its proven therapeutic properties under the Act.

RIRDC responded to this by granting additional funding to Agriculture Western Australia through Project No DAW-57A to review the information currently available, assess the value of rat models and other biological and chemical analysis in determining the therapeutic properties of the oil and assess the effect the existing patents had on future research and development into emu oil.

Procedure

A meeting of Industry and Scientists involved in emu oil research was arranged to review the available information and formulate a program of research and development.

An attorney was engaged to research the application of the emu oil patents and supply the "cover file" for the Emu Products Western Australia Pty Ltd., patent

An extensive search of the literature was undertaken to review the suitability of available techniques to determine the therapeutic properties of emu oil.

Work was commenced to develop expertise in the use of the carrageenan anti-inflammatory rat model and the cooperation of Dr Michael Whitchouse, PHARMA QUEST, who had expertise in the use of the mycobacterium, poly arthritis anti-inflammatory rat model, was established.

Industry Meeting

Attendance

P. Frapple	New Industries Programme Agriculture Western Australia
S. Birkbeck	Mt Romance Pty Ltd.
Dr. C. Davis	Department of Primary Industry, Queensland
Dr. S. Davies	Chairman, Emu Farmers Federation of Australia Research Committee
Dr T. Ellis	Veterinarian Agriculture Western Australia
P. O'Malley	Research Officer Agriculture Western Australia
Dr J. Snowden	Senior Research Officer Agriculture Western Australia
Dr. D. Williams	Western Emu
Dr. M. Whitehouse	Medical Research Consultant

Situation Report

Participants expressed concern at the possibility of overproduction of oil and the total lack of information available to marketeers wishing to promote the oil. The cosmetic consumption of emu oil was unlikely to rise sharply until its'therapeutic value had been demonstrated. Cosmetic companies were interested in emu oil because of its anti inflammatory, cellular regeneration and penetrating properties.

Companies had undertaken expensive research programs and to date this money had largely been wasted. There was a need for industry to pool its information and develop generic promotional material.

Past research

Past research had demonstrated that emu oil did have anti inflammatory properties but much of the work was subject to intellectual property and patent constraints. Work on the isolation of the active component had been well advanced when funding difficulties arose but the active fraction had never been evaluated.

Work commissioned by Mt Romance also showed that emu oil had mild anti inflammatory and cellular regeneration properties but the data was not conclusive. Similarly recent research on the skin penetrating properties of emu oil would not be published but Sydney University had been requested to develop a protocol to allow the work to continue.

Agriculture Western Australia had recently commenced development of an anti inflammatory rat model and while preliminary trials were positive more work to clarify the responses observed was needed.

An extensive search of the literature had failed to find anything of real value.

Status of Existing Patents

The patent on the use of emu oil in combination with other known anti inflammatory compounds applied in America and Japan. While it had been challenged in Australia it was still possible for the company to defend the challenge at some time in the future. There was no raw data behind the patent application which could be used to gain registration by the TGA. All the information was contained in the patent.

It was believed an American group had submitted a patent for the use of emu oil to lower cholesterol and improve cardiovascular function but this had not been applied.

Priorities for Future Research

1. **Therapeutic properties of emu oil**

1.1 Demonstrate the anti inflammatory properties of emu oil.

(i) Develop repeatable models to demonstrate the anti inflammatory properties of emu oil.
(ii) Correlate activity with particular fractions of the oil and identify a possible marker of activity.
(iii) Determine the effect of diet, age, season, rendering process and source of fat on activity.
(iv) Develop standards for emu oil which reflect its therapeutic activity

1.2. Anti inflammation

Evaluate the penetration of emu oil; the use of penetrant enhancers and carriers; mode of application, dermal, oral, intramuscular, intravenous.

1.3. Cell regeneration and wound healing

Determine the cell regeneration and wound healing properties of emu oil.

1.4. Anti Viral/microbial properties of emu oil

Determine the anti viral and anti microbial activity of emu oil

1.5. Cholesterol lowering and cardiovascular effect of emu oil

Investigate the effect of emu oil on blood cholesterol and cardiovascular function.

2. **Move to clinical trials of identified therapeutic effects.**

3. **Registration by the Therapeutic Goods Administration.**

Action

Research projects to investigate items 1.2, 1.3, 1.4, 1.5, will be called for in years 1 and 2 of the program. Item 1. 1 to become part of Agriculture Western Australia current research program.

Clinical trials will be initiated in year 2 - 3 with a view of achieving TGA registration on completion of the project.

A generic promotional brochure on emu oil would be produced.

Research Briefs for the research priorities identified were subsequently prepared and circulated widely and formed the basis for the initiation of three RIRDC funded emu oil research project. Two projects (DAW-82A and DAW-82B) were to be carried out by Oi Agriculture Western Australia addressing Items 1.2 and 1.3. The University of WA was selected to undertake a research project addressing Item 1.4.

Emu Oil Patents

It was confirmed that United States Patents 5,431,924 (July 11,1995) Emu Products Western Australia Pty Ltd., and 5,472,713 (), New World Technology Incorporated, John Caputo, applied in the United States.

Australian Patent Application No 89452/91 in the name of Emu Products Western Australia Pty Ltd " Anti-inflammatory Composition Derived from Emu Oil" had not proceeded beyond the "request for examination" phase and the application would not proceed any further until a request for examination had been filed. It was also to be challenged on the basis of prior use in Australia.

The claim related only to a "yellow component derived from emu oil" using a specific extraction process and the use of a mixture of emu oil and a compound which allows the active ingredient to be transported across the skin or mucous membranes.

Information contained in the Patent applications and the "cover file' of the Emu Products US Patent did not supply sufficient clinical data to gain registration for emu oil under the Therapeutic Goods Act.

Rat Models

An extensive search of the literature showed that the carrageenan and polyarthritis rat models were the most appropriate assays to demonstrate the anti-inflammatory properties of emu oil. Agriculture Western Australia conducted a number of preliminary trials using the carrageenan model to gain preliminary data and standardise the technique.

Michael Whitehouse, Pharma Quest, who had been involved with the initial work which led to the emu oil Patent and operated the poly arthritis rat model agreed to collaborate in the research.

Carrageenan Rat Model

To determine if emu oil applied topically has anti-inflammatory action on rat paw inflammation induced by injected carrageenan.

In this model ten animals are used for each treatment group. The animals are anaesthetised using halothane gas anaesthesia and the area just behind their necks shaved to expose approximately 6 square centimetres of dorsal skin. Each animal will then receives a single deep intra-dermal injection of 0. 1 ml of a solution of 1 %(w/v) of carrageenan in physiological saline into the dorsal skin of the right rear paw pad. Treatments are applied, immediately after injection, to the exposed skin behind the neck and to the right paw. The thickness of the rear right paw are measured immediately prior to treatment. Further measurements are taken at 2, 4 and 6 hours after injection. Treatments may be re-applied after each paw measurement.

If the effects of emu oil on the development of granulation tissue are to be examined the paw diameters are measured at 24, 48, 72 and 96 hours after injection of the carrageenan and further oil treatments may be applied after measurement.

Poly arthritis Rat Model

To determine if emu oil applied topically has anti-inflammatory action on the poly arthritis induced by the injection of a mixture of M. tuberculosis in squalene into the tail base of rats.

In this model, an experimental poly arthritis is preestablished by sensitising rats to a mycobacterium cell wall antigen. When the first signs of arthritis are manifested, generally after 1 0 days, the rats are shaved just behind the neck to expose approximately 6 square centimetres of dorsal skin. To this is applied the emu oil plus a penetration enhancer, usually cineole 15% w/v, with careful rubbing to ensure minimal spill-off and optimal penetration. This procedure is repeated for at least 4 days, whilst the arthritis attains maximal severity in the controls. The controls are treated with a bland oil, usually olive, admixed with cineole. Twenty four hours after the last treatment, the severity of the arthritis is assessed by measuring the size of the rear paws, maximal tail swelling and scoring the inflammation in the front paws.

References

Bennett G. Observations principally on the animal and vegetable products of New South Wales, Gatherings of a naturalist in Australasia. London: John Van Voorst, Paternoster Row: 1860.
Ghosh P, Whitehouse M, Dawson M, Turner A. Anti-inflammatory composition derived from emu oil. United States patent number 5,431,924. 1995.
Fein E, Caputo J, Nagal K. Therapeutic uses of emu oil. United States patent number 5,472,713. 1995.
Whitehouse MW. Adjuvant induced polyarthritis in rats. In: Greenwald RA, Diamond HS, eds. Handbook of models for rheumatic diseases. Voll. Boca Raton: CRC Press: 1988:3-16.
Rainsford KD. Adjuvant polyarthritis in rats: is this a satisfactory model for screening anti-arthritic drugs? Agents Actions 1982; 12: 452-5.
Billingham MEJ. Models for arthritis and the search for anti-arthritic drugs. Phannac Ther. 1983; 21: 389-417.
Hashida M. Yamashita F. Terpenes as pentration enhancers. In: Smith EW Maibach MI, eds. Percutancous penetration enhancers. Boca Raton: CRC Press: 1995:309-21.

Other Models

As part of this project RIRDC had agreed to support a limited amount of clinical testing of emu oil by Mt Romance. Two tests were performed by Australian Photobiological Testing Facility Pty Ltd.

Short Term Irritancy Test

Six subject were scored for erythema of the skin after a sample of emu oil had been applied to duplicate occluded areas of skin each day for 5 days. Water was used as a control. There was no visible response to the emu oil and while the test were unequivocally negative the small number of subjects limited its significance to a "pilot" status.

Anti - inflammatory Test

2 mg/cm2Diprosone, Methylsalicylate, pure emu oil, emu oil product water and no treatment were applied to 30 cm square test areas of skin of three subjects irradiated with a solar simulator 16 - 24 hours prior to application to produce erythema. The amount of inflammation was evaluated every 2 hours after application for 8 hours and then 24 hours later.

The responses on all three subjects were variable and inconsistent and there were no significant effects.

Emu Oil Leaflet

In response to a request from industry for a leaflet to promote emu oil a " generic" emu oil leaflet "the good oil on emu oil" was produced to the final proof stage. At this point advice was sought from the Therapeutic Goods Administration as to the leaflets acceptability in respect to the Therapeutic Goods Act. Unfortunately the reply from them was not positive and they raised a number of concerns with the leaflet.

"Standing alone 1 accept that the leaflet is of a generic nature. However, while the leaflet is not an Advertisement for a specific good (in this context), 1 believe that it is certainly an advertisement for a particular class of therapeutic goods, namely emu oil. You may also be interested to note that such interpretations are supported by High Court and Federal Court Precedents.

With this in mind, 1 have noted that the leaflet includes the statement :

> *In Australia, an emu oil preparation has been registered in the Australian Register of Therapeutic Goods (ARTG) as an adjunct in the relief of dry scaling skin due to dermatitis, senile and infantile eczema, neurodermatitis, ichthoyosis and soap and irritant dermatitis.*

In regard to this particular claim, 1 would draw your attention to Therapeutic Goods Regulation No.6 which states, in part –

> *A person must not publish an advertisement about goods for therapeutic use that contains a reference to the Act(other than in a statement of the registration or listing number of the goods); or a statement suggesting or implying that the goods have been recommended or approved by or on behalf of a government or government authority.*

The above statement is designed to convey some official endorsement for the particular emu oil preparation and is therefore unacceptable."

The reply also raised the concerns that the specific product referred to had only been issued a provisional registration number and while the leaflet was 'generic' in nature " consumers may be mislead into believing that any emu oil product is indicated for this purpose."

Concerns in terms of false/misleading /deceptive conduct provisions of the *Trades Practises Act 1974* and the fact that brochures which contain therapeutic claims cannot be associated with other products that are not included on the Australian Register of Therapeutic Goods were also raised.

Further correspondence clarified that a suitable statement to satisfy Regulation No. 6 referred to above which would not breach the legislation once the product had been approved for marketing was-

> *XXX(product name)* is registered in the Australian Register of Therapeutic Goods (AUST R *registration number)* as an adjunct in the relief of ...

and suggested that the services of a consultant with knowledge of the therapeutic goods regulatory framework be engaged. A 'consultants list' is available from the Technical Goods Administration Information Officer.

In view of the difficulties experienced with having the leaflet cleared by the TGA production was halted but an electronic copy of the proof is available should the industry wish to proceed further.

TGA Registration of Emu Oil

A number of conversations were held with representatives from the TGA and the following notes should be of interest.

Emu oil had not been registered as an 'active' therapeutic agent because the administration had not cited any evidence of its efficacy as a therapeutic.

Registration required at least one scientifically sound clinical trial. Preferably this would be submitted to the TGA following publication in a recognised scientific journal. However, it could be submitted directly to the TGA if confidentiality was an issue.

Animal models were acceptable as background evidence but there must be at least one human study. Animal studies could be acceptable as dose response trials. Successful animal studies were a normal prerequisite to interest researchers in a clinical study.

Generic oil testing is acceptable and advisable and would enable all industry participants to quote the efficacy of emu oil from the study when registering products without having to prove it with every application. The use of wintergreen oil in registered products was given as an example to this.

Although the recognised cost of an acceptable clinical study was " several hundred thousand dollars" it largely depended on who could be encouraged to undertake the work.

Under mutual recognition arrangements TGA registration was normally sufficient evidence to gain registration in the United States and Europe. If not the same evidence could be presented.

The industry could continue to register emu oil products which contained known therapeutic agents but could not make specific claims for the oil itself.