Proceedings 5th World Rabbit Congress, 25-30 July 1992, Corvallis – USA, 287-298

EVALUATION OF CALIFORNIAN, CHAMPAGNE D'ARGENT, NEW ZEALAND WHITE AND PALOMINO AS POTENTIAL SIRE BREEDS: II. CARCASS YIELD AND LEAN CUTABILITY TRAITS

S.D. Lukefahr, J.D. Roberts, J.K.A. Atakora and H.H. Hamilton

International Small Livestock Research Center
Department of Food Science and Animal Industries
Alabama A&M University, P. O. Box 264,
Huntsville, AL 35762, USA

Abstract

Carcass data were collected on 219 fryers from 91 litters representing four sire breeds: Californian (CAL), Champagne D'Argent (CHA), New Zealand White (NZW) and Palomino (PAL). All experimental sires (s=34) were mated to NZW does (d=58). Traits evaluated included: preslaughter, carcass, and total lean weights; pelt, viscera, abdominal fat and dressing percentages; forequarter, loin and hindquarter percentages of primal cuts, and lean-to-bone ratio. The mixed model consisted of sire breed (SB), contemporary environment (month by slaughter age group combination), and the linear covariate of litter size at weaning as fixed effects. Random effects included sire nested within SB, dam nested within sire, litter nested within dam and the random residual. Major comparisons showed NZW fryers to have the poorer dressing percentage ($P<.01$) and lean yield ($P<.01$) than the crossbreds (except for PAL X NZW in the latter). Gross margin analyses suggested economic benefits and(or) savings to both processor and consumer sectors as related to utilization of meatier crossbred fryers.

Introduction

Most processors pay rabbit fryer producers on a live weight basis with no consideration for conformation. Thus, there is little incentive to produce rabbits of exceptional carcass qualities; instead, the incentive is to simply produce a faster gaining, heavier fryer. Such a fryer could possibly have poor dress-out and low meat yield attributes. In this case, the producer may benefit more than the processor or the consumer. As an example, the New Zealand White (NZW) breed has demonstrated inferior carcass quality results in a number of previous studies (Heckman et al., 1971; Ouhayoun, 1977; Lukefahr et al., 1982, 1983; Mach and Trojan, 1985; Masoero et al., 1985; Ozimba and Lukefahr, 1991). It may be possible to overcome this disadvantage by crossbreeding the NZW to other breeds noted for superiority in carcass traits.

Use of breeds superior for carcass traits could improve carcass and(or) meat yield trait levels than those currently observed in the industry, which primarily utilizes NZW purebred fryers. Better dressing percentages will benefit the processor, as will improved lean yield traits with regard to deboned products (e.g. fillets, nuggets, patties and sausage). Processors should consider paying producers on a carcass weight basis (accounting for dress-out rate) to provide a proper incentive to supply fryers that have less slaughter and (or) inedible wastes.

In turn, consumers could be more attracted by higher lean-to-bone ratios (cutability), thus giving rabbit meat a more comparative advantage over other meats. The potential health benefits associated with rabbit meat consumption (Rao et al., 1979; Lukefahr et al., 1989; USDA, 1989) may also be used to increase demand to improve the economic security of the meat rabbit industry. Hence, developing proper incentives to produce a better meat rabbit could benefit all sectors of the industry.

The objective of this investigation was to compare sire breed groups, purebred and crossbred, for carcass traits of commercial importance to the meat rabbit industry.

Materials and Methods

Breeds and Stock Management. The sire breeds evaluated included Californian (CAL), Champagne D'Argent (CHA), New Zealand White (NZW) and Palomino (PAL). All bucks were mated to NZW does, so three crossbred and one purebred group was involved. Distribution of fryers slaughtered in the study according to litter, dam, sire and sire breed is shown in Table 1. A description of the breeds, diet, housing and litter management procedures have been presented in the previous companion paper (Roberts and Lukefahr, 1992). At 70 d of age, 1 to 4 fryers per litter were randomly selected for slaughter. Fryers were separated from feed and water approximately 24 hours prior to slaughter at 71, 72 or 73 days of age, were sacrificed by sudden cervical dislocation, and were processed at the Alabama A&M University processing facility.

Table 1. Number of sires, dams, litters and fryers by sire breed.

Sire breed	Sires	Dams[a]	Litters	Fryers
Californian	9	16	24	54
Champagne D'Argent	8	11	19	52
New Zealand White	9	15	22	57
Palomino	8	16	26	56
Total	34	58	91	219

[a]All dams were of the New Zealand White breed.

Carcass Trait Definitions. Preslaughter, hot carcass and adjusted total lean weights were recorded. Hot carcass weight did not include the head, giblets (heart, liver and kidneys) or abdominal fat. Dressing percentage was calculated as hot carcass plus abdominal fat plus giblet weights, divided by preslaughter weight, times 100. Adjusted total lean weight was twice the hand-deboned, lean tissue weight separated from one longitudinally split carcass half. Total lean weight and lean-to-bone ratio were measured as indicators of apparent cutability. The remaining carcass half was divided into retail cuts: forequarter (forelegs and rack), loin and hindquarter (hindlegs and rump) primals. Each primal cut was expressed as a percentage of carcass weight. Pelt and visceral weights were expressed as a percentage of preslaughter weight, whereas abdominal fat weight was expressed as a percentage of hot carcass weight.

Statistical Procedures. The hierarchical design involved sampling eight or nine bucks per sire breed with one or two NZW does being randomly assigned to each buck. Each doe contributed one or two litters, for a total of 219 fryers involved in the experiment (Table 1). Data were blocked for the contemporary environmental effects of month of weaning (8 classes) by age at slaughter (3 classes). Data were adjusted by linear regression for litter size at weaning at 28 days of age. The sire breed x contemporary effects interaction, dam parity and fryer sex effects were not included in the final model because they were found to be non-significant in preliminary analyses.

Generalized least squares analyses of the data for unequal subclass numbers were performed employing the General Linear Mixed Models (GLMM) statistical package (Blouin and Saxton, 1990) for a model including sire breed, contemporary effects and the linear covariate of litter size at weaning, and the independent random effects of sire within sire breed, dam within sire, litter within dam, and random residual effects. Sire breed was tested by the sire within sire breed term (df=29), whereas month and slaughter age main effects and also the litter size covariate were tested by the litter within dam term (df=15). Restricted maximum likelihood estimates of the observational components of variance for nested random sire, dam, litter and residual effects were used to obtain best linear unbiased estimates (BLUE) for model fixed effects.

Generalized least squares means were computed for each sire breed group. Preplanned contrasts included all possible pair-wise comparisons between sire breed groups for average carcass trait performance. Contrast comparisons were tested ($P<.10$) for statistical significance using the Student's t-test. Despite non-orthogonality, these contrasts were deemed most meaningful with respect to conducting gross marginal analyses to draw economical inferences based on these results, and, ultimately, in making potential recommendations to commercial producers and processors. Specifically, contrast differences would evaluate sire breeds on the basis of additive genetic merit if heterosis for these postweaning growth and carcass traits can be assumed to be of minor importance (Carregal, 1980; Lukefahr et al., 1983; Masoero et al., 1985; Brun and Ouhayoun, 1989).

Results and Discussion

Analysis of Variance. Presentation of sire breed comparisons will be made in the next section. Contemporary environmental effects due to the combination of month of weaning and age at slaughter subclasses were significant for preslaughter, hot carcass and total lean weights, and also forequarter and loin primal percentages and lean-to-bone ratio. The linear covariate due to litter size at weaning negatively influenced ($P<.05$) the same three weight traits, while positively influencing the hindquarter primal percentage.

Sire Breed Comparisons. Least squares sire breed means, pair-wise contrasts and levels of significance are shown in Tables 2 and 3. NZW purebreds had lighter ($P<.01$) preslaughter, hot carcass and total lean weights than CHA X NZW crossbred fryers. Also, hot carcass and total lean weights were lighter ($P<.01$) in NZW purebred than CAL X NZW crossbred fryers. Preslaughter weight tended ($P<.10$) to be heavier by 74 grams in favor of CAL X NZW over NZW. CHA X NZW and CAL X NZW crosses were significantly heavier for all three weights than the PAL X NZW cross. The CHA X NZW cross had 72 ($P<.10$), 51 ($P<.05$) and 45 ($P<.10$) g heavier preslaughter, carcass and total lean weights compared to the CAL X NZW cross.

NZW purebreds had significantly higher visceral contents, lower abdominal fat and lower dressing percentages than CAL X NZW, CHA X NZW and PAL X NZW crossbreds (Table 2). Pelt percentages were higher by .6 in the CAL X NZW ($P<.01$) and .5 in the PAL X NZW ($P<.05$) crosses than the NZW purebreds. The CAL X NZW cross had 1.1% higher visceral content, 1.03% lower abdominal fat and 1.6% lower dress-out than the CHA X NZW cross ($P<.01$). A similar pattern was detected in CHA x NZW vs PAL X NZW comparisons for the same traits, although the difference for visceral content was significant at the $P<.05$ level.

No significant sire breed differences were found in forequarter cut percentage. NZW purebreds had the lower ($P<.05$) loin cut percentage and higher hindquarter cut percentage than the crossbreds (Table 3). The hindquarter cut was lower by .9% ($P<.01$) in CAL X NZW than in CHA X NZW and by .7% ($P<.05$) in CAL X NZW than in PAL X NZW comparisons. CAL X NZW and CHA X NZW crossbreds had better lean-to-bone ratios, differences of .28 ($P<.10$) and .54 ($P<.01$), respectively, compared to NZW purebreds. Also, the CHA X NZW cross had a better lean-to-bone ratio by .42 than the PAL X NZW cross ($P<.05$).

Previous domestic studies clearly demonstrating higher dressing percentages and cutability (lean yield) for the CAL X NZW crossbreds when compared to NZW purebreds support present results (Lukefahr et al., 1983; Ozimba and Lukefahr, 1991). European reports (Heckman et al., 1971; Niedzwiadek, 1979; Bednarz and Frindt, 1975; Auxilia and Masoero, 1986; Deltoro and Lopez, 1986; Brun and Ouhayoun, 1989), however, have tended to show only small differences between CAL and NZW purebreds or crossbreds. Line

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differences for carcass traits may exist between U.S. and European CAL and NZW breed stocks. As breeds of U.S. origin, and following the first importations to Europe in the 1950's and 1960's (Lebas et al., 1986), it is rather likely that some outcrossing to other breeds was made to expand the small initial genetic base(s), and ensuing selection strategies may have emphasized different characters than practiced in the U.S.

Table 2. Least squares sire breed means and contrasts for carcass yield traits[a]

Item	PSW, g	HCW, g	Pelt, %	Visc, %	Fat, %	DP
Californian (CAL)	1,841	926	11.9	17.1	2.12	54.7
Champagne D'Argent (CHA)	1,912	977	11.6	16.0	3.15	56.3
New Zealand White (NZW)	1,767	849	11.3	18.3	1.83	52.4
Palomino (PAL)	1,731	866	11.8	16.8	2.14	54.9
CAL - NZW	74†	76**	.6**	-1.1**	.29*	2.3**
CHA - NZW	146**	128**	.3	-2.3**	1.32**	3.8**
PAL - NZW	-36	16	.5*	-1.5**	.31*	2.4**
CAL-CHA	-72†	-51*	.3	1.1**	-1.03**	-1.6**
CAL - PAL	110**	60*	.2	.3	-.02	-.1**
CHA - PAL	181**	112**	-.2	-.8*	1.01**	1.4**
SE[b]	58	34	.2	.5	.18	.5

[a] Trait abbreviations: PSW = preslaughter wt, g; HCW = hot carcass wt, g; PELT = pelt wt divided by PSW, %; VISC = visceral wt divided by PSW, %; Fat = abdominal fat wt divided by HCW, %, and DP = dressing percentage calculated as HCW plus giblet plus fat weights divided by PSW times 100.

[b] Average standard error for the sire breed means.

† $P<.10$, *$P<.05$, **$P<.01$.

Results from European research have identified the CHA as a suitable sire breed, especially for improving carcass trait performance through crossbreeding. Giavarini et al. (1978) observed improvements in dressing percentage and meat-to-bone ratio in CHA X

NZW crossbreds compared to NZW purebreds. Trojan and Mach (1982) found CHA crosses to have the heaviest average slaughter and carcass weights in an experiment involving 28 rabbit crosses, including CAL and NZW crosses. In addition, Auxilia and Masoero (1986) reported CHA-sired crosses to have higher dressing percentages than CAL- and NZW-sired crosses. These results are in agreement with those of the present study in classifying the CHA as a suitable sire breed for domestic crossbred (CHA X NZW) fryer production.

Table 3. Least squares sire breed means and contrasts for primal cut and lean yield traits[a]

Item	FQR, %	Loin, %	HQR, %	LBR	Lean, g
Californian (CAL)	42.2	21.7	37.7	4.09	736
Champagne D'Argent (CHA)	42.0	21.5	38.5	4.35	781
New Zealand White (NZW)	42.5	20.7	39.1	3.81	668
Palomino (PAL)	42.4	21.6	38.3	3.93	682
CAL - NZW	-.3	.9*	-1.4**	.28†	69**
CHA - NZW	-.6	.8*	-.5†	.54**	113**
PAL - NZW	-.1	.9*	-.7*	.12	14
CAL - CHA	.3	.2	-.9**	-.26	-45†
CAL - PAL	-.2	.1	-.7*	.15	54*
CHA - PAL	-.5	-.1	.2	.42*	99**
SE[b]	.3	.5	.3	.14	31

[a] Trait abbreviations: FQR = forequarter cut percentage; LOIN = loin cut percentage; HQR = hindquarter cut percentage; LBR = total lean-to-bone ratio, and LEAN = total lean wt, g.

[b] Average standard error for the sire breed means.

† P<.10, *P<.05, **P<.01.

Only one previous investigation (Grobner et al., 1985) documented NZW and PAL purebred differences for carcass traits. These co-workers reported that the NZW had the heavier preslaughter weight by 430 grams but dressing percentage was similar (difference of .3%), based on 16 fryers per breed. In this study, the NZW had a 35 gram heavier preslaughter weight but a 2.42% lower dressing percentage compared to the PAL X NZW cross.

Gross Margin Analysis. As described in the preceding companion paper (Roberts and Lukefahr, 1992), a gross margin analysis was performed to shed some economic light on the results from this investigation. The first analysis applied to the processor sector on the basis of dressing percentage results across sire breed groups. A market cost range of $1.32 to $1.98 per kg ($.60 to $.90 per lb) for purchasing live fryers compared to a wholesale (broker) price range of $3.85 to $4.96 per kg ($1.75 to $2.25 per lb) was considered to account for national and(or) cyclical market trends. Of course, fryers purchased at the highest cost of $1.98 per kg ($.90 per lb) and sold at the lowest price of $3.85 per kg ($1.75 per lb) leaves little to no profit margin for the processor. Sire breed groups possessing the highest dressing percentages would be more profitable to the processor, all things being equal. For the gross margin analysis, the following assumptions were made:

1) All fryers were slaughtered at 10 weeks of age, and the data were assumed to be representative of fryers from the sire breed groups marketed at that age;

2) Processing and handling costs were assumed to be similar across sire breed groups, and

3) The value of the by-products (e.g. pelt, blood and organs) was ignored but was assumed to be similar across sire breed groups.

The first assumption must be made in order to use the statistical results from carcass trait analyses. Ten weeks may be considered typical of the year-round average market age for the industry. Processing and handling costs per fryer (or weight basis) and the value for by-products will vary among processors.

Results from the gross margin analysis are presented as differences from purebred NZW fryer performance (Table 4). The sire breed group deviations were all positive. This indicates greater potential net returns to the processor for the three crossbred groups. This is because the NZW had the poorest dressing percentage. The largest calculated gross margins were +.28, +.44 and +.13 dollars for CAL X NZW, CHA X NZW and PAL X NZW sire breed groups, respectively, at a market cost of $1.32 per kg and a wholesale price of $4.96 per kg. In other words, to a processor a 2 pound carcass from a CHA X NZW crossbred fryer should represent a +.88 dollar economic advantage over a purebred NZW fryer.

A gross margin analysis was also conducted with respect to the consumer sector. This analysis was based on lean yield (cutability) from carcasses representing the four sire breed groups. A consumer price range of $5.51 to $8.81 per kg ($2.50 to $4.00 per lb) of meat was assumed. Meat consists primarily of lean and bone. The sire breed group least squares means for lean-to-bone ratio was taken, and divided by 1 plus the same ratio value (e.g. 3.81/ (1+3.81) = .792 for NZW). This lean proportion figure was then divided into the consumer price figure to determine the cost per unit of lean (e.g. $5.51 per kg divided by .792 = $6.96 per kg). Similar calculations were made for the other sire breed groups, values being expressed as deviations from NZW values. Further, these calculations were repeated across the consumer price range.

Table 4. Gross margin analysis: projected net returns to processors for CAL-, CHA- and PAL-crossbred expressed as deviations from NZW purebred fryers.

		Wholesale meat price, $/kg ($/lb)		
		3.85 (1.75)	4.41 (2.00)	4.96 (2.25)
Market fryer cost, $/kg ($/lb)	SB[a]			
1.32 (.60)	CAL	+.20[b]	+.24	+.28
	CHA	+.30	+.37	+.44
	PAL	+.11	+.12	+.13
1.54 (.70)	CAL	+.18	+.22	+.27
	CHA	+.27	+.34	+.41
	PAL	+.12	+.13	+.14
1.76 (.80)	CAL	+.16	+.21	+.25
	CHA	+.24	+.31	+.38
	PAL	+.13	+.13	+.14
1.98 (.90)	CAL	+.15	+.19	+.23
	CHA	+.20	+.28	+.35
	PAL	+.13	+.14	+.15

[a] Sire breed (SB) abbreviations: CAL = Californian; CHA = Champagne D'Argent; NZW = New Zealand White, and PAL = Palomino.

[b] For illustration, the first value of +.20 was calculated by [(+.926 kg)(3.85 $/kg) - (+1.841 kg)(1.32 $/kg)], where contrast deviations (e.g. CAL - NZW) for HCW (hot carcass wt) and PSW (preslaughter wt) are taken from Table 2.

Since the purebred NZW had the lowest lean-to-bone ratio, negative deviations were consistently observed for the crosses, indicating lower costs per unit of lean for the consumer (Table 5). Also, higher consumer prices were related greater dollar savings. The amount of savings was greatest for CHA X NZW, followed by the CAL X NZW, and the PAL X NZW sire breed group. Although the deviations (gross margins) appear small in the table, regular consumers of rabbit meat should benefit the most from purchasing carcasses from CAL X NZW and CHA X NZW crossbred fryers. If the carcasses were further processed into fillets or nuggets, processors should benefit by purchasing the meatier crossbred fryers.

Table 5. Gross margin analysis: projected consumer cost of lean for CAL-, CHA- and PAL-crossbred expressed as deviations from NZW purebred fryers.

	Consumer lean price, \$/kg			\$/lb
SB[a]	5.51 (2.50)	6.61 (3.00)	7.71 3.50)	8.81 (4.00)
CAL	-.10[b] (-.05)	-.12 (-.05)	-.14 (-.06)	-.16 (-.07)
CHA	-.18 (-.08)	-.22 (-.10)	-.25 (-.11)	-.29 (-.13)
PAL	-.04 (-.02)	-.05 (-.02)	-.06 (-.03)	-.07 (-.03)

[a] Sire breed (SB) abbreviations: CAL = Californian; CHA = Champagne D'Argent; NZW = New Zealand White, and PAL = Palomino.

[b] For illustration, the first value of -.10 (-.05) was calculated by 5.51 \$/kg (2.50 \$/lb) divided by total lean fraction (LBR/LBR + 1), and expressed as a deviation of CAL - NZW values (LBR sire breed means in Table 3.) The -.10 deviation represents dollar savings per kg (.05 \$/lb) due to higher lean cutability.

Conclusions

Commercial producers may observe comparable if not improved production by mating CAL or CHA bucks to their NZW does. Previous domestic reports (Lukefahr et al., 1983; Ozimba and Lukefahr, 1991) have inferred that the CAL X NZW cross may be more productive and(or) profitable than the purebred NZW rabbit. In this paper, the CHA X NZW cross, also yielded exceptional carcass and lean qualities. Results from these two companion papers would indicate that commercial production of either a CAL X NZW or a CHA X NZW crossbred fryer should produce a higher quality, more profitable meat rabbit.

Both processors and consumers should see economical benefits from purchasing CAL X NZW or CHA X NZW crossbred fryers. Such an economic realization could increase the demand for meatier fryers among processors and consumers alike so that commercial producers could benefit through proper incentives (such as bonuses paid according to higher dressing percentages or lean cutability). Economic gains were less when the PAL X NZW crossbred was compared to NZW purebred fryers. In conclusion, production of CAL X NZW or CHA X NZW crossbred fryers should enhance profitability or economy, directly or indirectly, for all three sectors of the commercial meat rabbit industry.

Acknowledgements

This research project was supported by a grant from the Coop. State Res. Serv./USDA, and published as Paper No. 199T, Journal Ser., Agric. Exp. Sta., Alabama A&M Univ., Huntsville 35762. The authors are indebted to Mrs. Jeanette Caughlin (Caughlin Farm, Mount Hermon, LA), Mr. Keith Franklin (Kentucky Specialty Meats, Princeton, KY) and Dr. David Harris for sharing information on the economics of rabbit meat processing. Grattitude is also expressed to Dr. Hezekiah Jones (Professor of Economics, Alabama A&M Univ.) for his assistance in the economic analyses, and to Dr. James McNitt who generously reviewed both companion papers and provided several useful suggestions.

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