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Effect of Dietary Protein on Growth, Breast Muscle Thickness and Blood Parameters of Pekin Ducks Selected for leanness Using Ultrasound Scanning

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Abstract: Male and female Pekin ducks selected for greater breast muscle thickness were used to determine the effect of dietary protein on growth performance and breast muscle thickness (MT). The dietary programs were high protein program (HP) that consisted of 25, 23, and 21 % CP for the starter, grower, and finisher, respectively; medium protein program (MP) that consisted of 23, 21, and 19 % CP for the starter, grower, and finisher, respectively; and low protein program that consisted of 21, 19, and 17 % CP for the starter, grower, and finisher, respectively. Males were heavier than females throughout the growth trial for the three dietary programs. Increasing dietary protein improved body weight, MT, and cumulative feed:gain ratio at 6 wk of age. Daily measurements of body weight and MT from 42 to 49 d revealed that males receiving HP and MP had similar body weight during wk 7, and were heavier than those receiving LP. Increasing dietary protein improved total breast thickness, and HP had greater MT than MP and LP that had similar MT measurements. Body weight and MT increased with age for both sexes, but MT of males receiving HP at 45 d was comparable to those of MP and LP at 48 and 49 d. Female ducks had similar body weight on HP and MP, but were heavier than the ducks on LP. Similarly to males, increasing dietary protein improved the females MT. These results indicate that males responded more efficiently to increasing dietary protein than females, and males selected for greater MT can be slaughtered at earlier age when fed the high protein program.

Key words: breast muscle thickness, ultrasound scanning, pekin ducks, growth performance, dietary protein

INTRODUCTION

After representing one third of beef production in 1950, poultry production is currently greater than beef, and while pork and beef productions slow down, poultry growth rate is increasing and is the highest among meat animals [1]. Poultry meat consumption has also shown a strong increase since the 1950's due to its lower price and the public perception of it as healthier compared to red meat [2, 3]. The duck meat is still a small contributor to the poultry industry. However, for the last few decades, there was a remarkable increase in meat type duck production orchestrated by the improvement of growth rate and feed efficiency through selective breeding [4].

Pekin ducks were selected for greater body weight and breast muscle thickness using a needle probe [5]. The authors reported 0.4 mm increase in breast muscle thickness over seven generations. Selection over two generations resulted in breast muscle thickness improvement by 15 and 14 % in the breast muscle line compared to the control line and the line selected for body weight [6]. From the comparison of broiler stocks of the year 1957 to those of 1991, it was concluded that 80 % of the improvement in broiler performance was due to genetics that can only be effective under the current nutritional and management practices [7].

Similarly to broiler chicken, the growth response of males and females Pekin ducks is different and indicates that they have different nutritional requirements. Male chickens showed a greater response to dietary protein than females [8, 9]. Separate rearing of sexes resulted in better performance than mixed rearing in Pekin ducks, especially that the lean males, selected for greater breast muscle thickness, were able to reach market weight at 42 d of age [10]. Furthermore, a 36 % increase in the breast muscle development was observed in both sexes from 42 to 49 d of age. Males had greater breast muscle thickness at 42 d but not at 49 d of age indicating that the diet, which was the same for both sexes, may not be suitable to meet the higher potential of males for breast muscle development. Reducing the growing period of broiler chickens by 5 d would allow the producer to raise an extra flock per house per year, and the reduction of 0.17 in feed conversion accounts for a reduction of

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more than 5 % in production cost [11]. Feed conversion was improved 2 % for a day reduction in reaching market weight in Pekin ducks [4]. The decline in feed efficiency during wk 7 questions the benefit of keeping the ducks to 49 d [12]. These observations represent a good reason to provide the appropriate nutritional program to meet the requirements of ducks selected by ultrasound for breast muscle thickness and explore the possibility of reducing the time of Pekin ducks to reach market weight.

The objectives of this experiment was to determine the appropriate feeding program (starter, grower, and finisher) in terms of dietary protein for male and female Pekin ducks selected for greater breast muscle thickness and to examine the possibility of reducing their age to market.

MATERIALS AND METHODS

Day 1 to 42: A total of 600 ducklings were sexed at hatching (300 males, 300 females), weighed in groups of 25 and randomly allocated into 24 floor pens at 0.22 m^2 per bird. All birds were individually identified with wing bands at 14d of age. Individual body weight and pen feed consumption were recorded at 14, 28, and 42 d of age. The ducklings received 24 h of light for the first wk and then 16 hr of light for the rest of their growth period. At 14 d of age, the light intensity was reduced to 5 lux to avoid cannibalism. The ducklings were offered three dietary programs that differed in the percent of crude protein. The three growth periods were divided as follows: 0-14d starter, 14-28d grower, 28-49d finisher. The high dietary protein program (HP) consisted of 25, 23, and 21 % CP for the starter, grower and finisher diets, respectively. The medium dietary protein program (MP) consisted of 23, 21, and 19 % CP for the starter, grower and finisher diets, respectively. The low dietary protein program (LP) consisted of 21, 19, and 17 % CP for the starter, grower and finisher diets, respectively. The characteristics of the diets are presented in Table 1. All diets were served pelleted and *ad libitum*.

Day 42 to 49: At 42 d of age, 300 ducklings (25 birds/sex/dietary program) were probed using ultrasound to measure their total breast and breast muscle thickness. The skin and subcutaneous fat of 60 birds (10 birds/sex/dietary program) were measured using a digital caliper. A total of 150 birds were followed with the ultrasound measurement on day 44, 46, and 48 when ultrasound and caliper measurement were taken. At 43 d of age, another group of 300 birds were weighed, and total breast and breast muscle thickness measured using ultrasound. At 45 d of age, both groups were probed, 150 birds of them has their ultrasound and caliper measurements taken, while the other 150 birds had their measurements taken on day 47 and 49. Five mL of blood were taken into heparanized tubes from each bird at 42, 45, 48, and 49 d of age prior to slaughtering. Plasma was analyzed for uric acid using a clinical discrete analyzer (Model VP super system, Abbott Laboratories, Mississauga, ON), and for total plasma protein using Bio-Rad Protein Assay (Car. No. 500-0006, Bio-Rad Laboratories, Hercules, CA). Carcass components and analyses complementing this study are reported elsewhere.

Ultrasound and caliper Measurements: Breast muscle thickness measurements were taken daily from 42 to 49 d of on live birds. The birds were held on their back on a restraining board by using Velcro tape over their neck and heels. A multipurpose ultrasound gel was used as a contact agent on the full feathered breasts. The ultrasound system used was an ECHO 1000 (Alliance Medical Inc., Montreal, QC) portable real-time ultrasound scanner, equipped with a 7.5 MHz linear array probe. The measurements were taken on a frozen image where the distance between 2 points (mm) was calculated using a built-in caliper. A digital caliper (Starrett electronic digital micrometer, No. 734MXFL, Athol, MA) was used to measure the double breast skin and fat thickness [13].

Statistical Analysis: Statistical analyses of the data were performed using the General Linear Models (GLM) procedures and mixed model of the SAS® library [14]. The performance data were treated as repeated measures with simple covariance structure, and the duck and pen were included as random effects for body weight and feed consumption, respectively. From day old to 42 d of age, the model included the effects of dietary program, sex, and their interaction. The dependent variables were body weight, feed consumption and conversion, and ultrasound and calliper measurements. From 42 to 49 d of age, the model included the effects of dietary program, age, and interaction for males and females. The dependent variables were growth performance parameters, breast muscle and skin plus fat measurements, and blood parameters. The multi-comparison Scheffe's test was used to separate the differences among the means for statistical significance ($P < 0.05$).

RESULTS AND DISCUSSION

Performance from day 1 to 4: Body weight and weight gain from day 1 to 42 d of age are presented in Table 2. There was no difference (P<0.05) between the initial average body weights of males and females that were 57.40 and 57.07 g, respectively. Both males and females had higher body weights on HP during the starting and the growing periods and both sexes had

Table 1: Characteristics of the experimental diets

Characteristics	Units	% CP				
		25	23	21	19	17
DM	%	88.56	88.52	87.72	87.99	88.08
CP	%	25.13	22.60	21.75	19.23	17.52
Fat	%	5.66	7.53	5.69	6.20	6.36
TME	Kcal/kg	3233	3239	3222	3230	3239
NDF	%	3.23	3.11	3.25	3.16	3.06
ADF	%	4.13	4.34	4.28	4.26	4.25
Na	%	0.15	0.16	0.15	0.15	0.15
Ca	%	0.90	0.78	0.93	0.83	0.80
Total P	%	0.64	0.60	0.64	0.59	0.57
Vit. A	IU/g	11.24	8.77	11.24	10.00	8.77
Vit. D	IU/g	3.50	2.63	3.50	3.07	2.63
Vit. E	IU/g	48.00	23.75	48.00	35.88	23.75

Table 2: Effect of dietary program (high protein, medium protein, low protein), and sex (M:male, F:female) on body weight and average daily gain (BWT and ADG) at 2,4, and 6 wk old pekin ducks (n=600)

Program	Sex	BWT 14d	ADG at 14d	BWT 28d	ADG (14-28d) (g)	BWT 42d	ADG (28-42d)
HP	M	720	51.01	2109	106.81	3020 [a]	70.10 [a]
HP	F	700	49.49	1986	98.9	2763 [d]	59.73 [c]
MP	M	677	47.82	2040	104.82	2955 [b]	70.44 [a]
MP	F	670	47.14	1965	99.58	2650 [e]	52.69 [d]
LP	M	657	46.09	1930	97.88	2875 [c]	72.73 [a]
LP	F	659	46.26	1868	93.02	2691 [e]	63.30 [b]
SEM		2.54	0.2	6.96	0.43	10.5	0.51
		Probabilities					
Program		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Sex		0.0767	0.0705	0.0001	0.0001	0.0001	0.0001
Program*Sex		0.1749	0.1745	0.1111	0.2227	0.0202	0.0001
Main Effects							
Program	HP	710 [a]	50.25 [a]	2047 [a]	102.86 [a]	2891	64.91
	MP	673 [b]	47.48 [b]	2002 [b]	102.20 [a]	2802	61.47
	LP	658 [c]	46.18 [c]	1899 [c]	95.45 [b]	2783	68.02
Sex	M	685	48.31	2026 [a]	103.13 [a]	2950	71.09
	F	676	47.63	1940 [b]	97.14 [b]	2701	58.57

[abcd] Means within columns with no common superscripts differ significantly ($P < 0.05$)

higher body weights on MP than on LP. From 28 to 42d of age, males and females on HP maintained a significantly higher body weight than the other programs, but the females on MP had similar body weights as the LP. Analysis of the average daily gain (ADG) within each period shows a significant difference between HP and the MP programs only during the starting period. The ADG during the growing period was similar between the two programs but higher than that of LP. From 28 to 42 d of age, males on the three programs had similar ADG, but the LP females gained significantly more weight than HP and MP females. Although HP ducks lost their superiority in ADG after the starting phase, MP and LP birds were unable to reach similar body weight to that of HP at 42 d of age where the interaction still showed that both males and females had significantly higher body weights than males and females on MP or LP. Japanese quails grown to 70 d had a significant improvement in body weight for only the first 4 wk when fed high dietary CP [15]. Increasing dietary protein with equal feed restriction resulted in similar body weight and improvement of breast muscle yield in breeder pullets at 4 wk of age [16]. Feeding male and female chicken different energy to protein ratios did not have an effect on body weight gain [17, 18]. Body weight gain from 4 to 8 wk improved in lean and fat chickens fed high dietary protein [19]. Lean line of chicken showed growth depression when dietary protein decreased [20]. Our data agrees with the literature suggestion that lean birds require more protein in their diet. Until 42 d of age, the results favor the high protein program for males and the medium protein program for females.

Ultrasound measurements of the total breast (TOT) and breast muscle (MT) thickness, and caliper measurement of the breast skin double thickness at 6 wk of age are presented in Table 3. There was an interaction between program and sex for TOT where the HP males had greater ($P<0.05$) TOT and the HP females had similar ($P>0.05$) TOT to MP females and LP males, but greater ($P<0.05$) than MP males and LP females. For both sexes, the HP had greater $P<0.05$) MT than both medium and low protein programs. These last two had similar ($P>0.05$) MT measurements. Males on all the programs had greater ($P<0.05$) MT than females. There was no effect ($P>0.05$) of dietary program or sex on the caliper measurement of breast skin thickness. The superiority of HP ducks in breast muscle thickness indicates that the high protein program is necessary for the improvement of growth rate and development of breast muscle thickness of males at 6 wk of age. While MP was suggested to be enough for the growth rate of females, HP resulted in greater breast muscle thickness at 6 wk of age. However, for both males and females, the body weight and breast muscle thickness are still considered below acceptable market range.

The effects of the dietary program and sex on feed consumption and feed:gain ratio (F:G) from 2 to 6 wk of age are presented in Table 4. There was no effect of dietary protein program on feed consumption at 2 wk, from 2 to 4 wk, 4 to 6 wk of age, or on the cumulative feed consumption from day old to 6 wk of age. The HP had a better ($P<0.05$) F:G than MP and LP during the first 2 wk. HP had a similar F:G to that of MP from 2 to 4 wk, and both had a better ($P<0.05$) F:G than that of LP. From 4 to 6 wk, the feed conversion of HP and LP were similar and better than that of MP. At 6 wk, the cumulative F:G of the ducks receiving HP was significantly better than those receiving MP or LP that were similar. There was no difference ($P>0.05$) in feed consumption between males and females up to 4 wk of age, but males on all the programs consumed more ($P<0.05$) feed than females from 4 to 6 wk and cumulatively up to 6 wk of age. Males had a better F:G than females from 2 to 4 wk, from 4 to 6 wk, and cumulative F:G at 6 wk of age. Similarly to our observation, low energy to protein ratio had no effect on feed intake, but improved feed efficiency from 7 to 42 d of age in male [17] and female broiler chickens [18]. Lean and fat chicken lines utilized the feed more efficiently as dietary protein was increased [20].

The growth of both males and females reached a plateau at 42 d of age. This decline in growth rate is associated with a significant decline in feed efficiency from 42 to 49 d of age [12].

Performance from 42 to 49: The effects of dietary protein program on daily body weight and ultrasound measurements of male ducks from 42 to 49 d of age are presented in Table 5. These data include 50 birds per dietary program per age. There was no significant interaction between dietary program and age for any of the three parameters. The difference in body weight between HP and MP males was not significant, but both were heavier ($P<0.05$) than the LP males. For all the dietary program, there was no significant increase in body weight after 47 d with a non-significant difference between 45, 46, and 47 d of age. Comparing the growth of males by dietary program shows that HP and MP males reached the same body weight during wk 7 after a significant difference at 6 wk. High dietary protein in the starter diet enabled a faster growth rate in quails [15]. The high protein program, in our study, induced a faster early growth followed by a slower growth, while the response to MP was a slower early growth followed by a faster growth. Both programs resulted in a similar body weight at which

Table 3: Effect of dietary program, and sex on total breast and breast muscle, and breast skin measurements of 6 wk old Pekin ducks

Program	Sex	Total breast (n=300)	Breast muscle (n=300)	Breast skin[1] (n=60)
		(mm)		
HP	M	10.16[a]	6.78	3.20
HP	F	9.64[b]	6.09	3.28
MP	M	9.10[c]	5.40	3.66
MP	F	9.31[bc]	5.33	3.09
LP	M	9.33[bc]	5.26	4.09
LP	F	9.14[c]	5.13	3.25
SEM		0.06	0.07	0.09
		Probabilities		
Program		0.0001	0.0001	0.1301
Sex		0.1615	0.0136	0.0992
Program*Sex		0.0409	0.0627	0.0657
Main Effects				
Program	HP	9.90	6.44[a]	3.24
	MP	9.20	5.36[b]	3.38
	LP	9.24	5.19[b]	3.67
Sex	M	9.53	5.81[a]	3.65
	F	9.36	5.52[b]	3.21

[abcd] Means within columns with no common superscripts differ significantly ($P < 0.05$)

[1] Double thickness of breast skin determined by a digital caliper.

Table 4: Effect of program and sex on feed consumption (FC) per bird, and feed:gain (F:G)[1] ratio of Pekin ducks at 2, 4, and 6 wk of age (n=24 pens)

Program	sex	FC2wk	FC2-4wk	FC4-6wk	CFC6wk[1]	F:G2wk	F:G2-4wk	F:G4-6wk	CF:G6wk[2]
		(g)							
HP	M	891	2678	2754	6323	1.35	1.93	2.92	2.09
HP	F	877	2580	2670	6127	1.36	2.06	3.42	2.23
MP	M	874	2618	2847	6339	1.41	1.94	3.13	2.15
MP	F	882	2624	2673	6178	1.44	2.03	3.58	2.28
LP.	M	857	2553	2755	6166	1.43	2.01	2.91	2.14
LP.	F	871	2566	2669	6106	1.45	2.12	3.24	2.27
SEM		6.12	13.88	22.34	33.47	0.01	0.02	0.06	0.01
		Probabilities							
Program		0.4313	0.0657	0.6167	0.2762	0.0001	0.0047	0.0019	0.0032
Sex		0.8537	0.2958	0.0202	0.0388	0.0966	0.0001	0.0001	0.0032
Program*Sex		0.6681	0.1445	0.6578	0.6558	0.8813	0.7204	0.4442	0.9689
Main Effects Program									
	HP	884	2629	2712	6225	1.36 [b]	1.99 [b]	3.21 [b]	2.16 [b]

Table 4: Continue

	MP	878	2621	2760	6258	1.42 ^{a}	1.98 ^{b}	3.36 ^{a}	2.22 ^{a}
	LP	864	2560	2712	6136	1.44 ^{a}	2.07 ^{a}	3.08 ^{b}	2.21 ^{a}
Sex	M	874	2616	2786 ^{a}	6276 ^{a}	1.4	1.96 ^{b}	2.99 ^{b}	3.01 ^{b}
	F	876	2590	2671 ^{b}	6137 ^{b}	1.42	2.07 ^{a}	3.42 ^{a}	3.42 ^{a}

[ab] Means within columns with no common superscripts differ significantly ($P < 0.05$)

[1] Cumulative feed consumption up to 6 wk of age.

[2] Cumulative feed to gain ratio at 6 wk of age.

Table 5: Effects of dietary program and age (42,43,44,45,46,47,48,and 49d) on body weight and ultrasound measurements of male Pekin ducks

Program	Age	Body weight (kg)	TOT (mm)	MT (mm)
HP	42 d	2.966	10.16	6.78
	43 d	3.088	10.29	7.30
	44 d	3.168	11.15	7.62
	45 d	3.222	11.40	7.87
	46d	3.267	11.74	7.99
	47d	3.272	12.55	8.77
	48d	3.274	12.63	8.71
	49d	3.295	13.05	9.17
MP	42 d	2.939	9.10	5.40
	43 d	3.025	9.65	5.66
	44 d	3.120	10.18	6.02
	45 d	3.142	10.4	6.52
	46 d	3.199	10.51	6.85
	47 d	3.238	11.58	7.68
	48 d	3.292	11.80	7.93
	49 d	3.313	12.39	8.24
LP	42 d	2.865	9.33	5.26
	43 d	2.925	9.67	5.72
	44 d	2.993	10.07	6.13
	45 d	3.041	10.19	6.38
	46 d	3.102	10.33	6.44
	47 d	3.171	11.03	7.35
	48 d	3.248	11.53	7.85
	49 d	3.250	11.77	7.99
SEM		0.01	0.05	0.05
			Probabilities	
Program		0.0001	0.0001	0.0001
Age		0.0001	0.0001	0.0001

Table 5: Continue

Program*Age		0.8827	0.5646	0.5655
Main Effects				
Program	HP	3.194^{a}	11.62^{a}	8.03^{a}
	MP	3.159^{a}	10.70^{b}	6.78^{b}
	LP	3.074^{b}	10.49^{c}	6.64^{b}
Age	42 d	2.923^{e}	9.53^{f}	5.81^{f}
	43 d	3.012^{d}	9.87^{e}	6.23^{e}
	44 d	3.094^{c}	10.47^{d}	6.59^{d}
	45 d	3.135^{bc}	10.66^{cd}	6.92^{c}
	46 d	3.166^{b}	10.86^{c}	7.10^{c}
	47 d	3.227^{ab}	11.72^{b}	7.93^{b}
	48 d	3.272^{a}	11.99^{b}	8.16^{ab}
	49 d	3.286^{a}	12.41^{a}	8.45^{a}

abcdef Means within columns with no common superscripts differ significantly ($P < 0.05$)

Table 6: Effects of dietary program and age (42,43,44,45,46,47,48,and 49d) on body weight and ultrasound measurements of female Pekin ducks

Program	Age	Body weight (kg)	TOT (mm)	MT (mm)
HP	42 d	2.773	9.64	6.09
	43 d	2.795	10.09	6.58^{d}
	44 d	2.854	11.02	7.35^{c}
	45 d	2.894	11.14	7.48^{c}
	46 d	2.944	11.33	7.83^{bc}
	47 d	2.957	12.15	8.33^{ab}
	48 d	3.02	12.43	8.63^{a}
	49 d	3.039	12.51	8.76^{a}
MP	42 d	2.718	9.31	5.33^{g}
	43 d	2.751	9.59	5.94
	44 d	2.807	10.6	6.85^{d}
	45 d	2.931	10.8	6.82^{d}
	46 d	2.941	11.17	7.33^{c}
	47 d	2.984	11.49	7.72^{bc}
	48 d	2.977	12.23	8.66^{a}
	49 d	3.057	12.44	8.71^{a}
LP	42 d	2.678	9.14	5.13^{g}
	43 d	2.742	9.19	5.42^{fg}
	44 d	2.758	9.79	5.78^{ef}

Table 6: Continue

	45 d	2.786	10.19	6.49^{d}
	46 d	2.84	10.87	6.58^{d}
	47 d	2.877	11.38	7.85^{bc}
	48 d	2.925	11.98	8.01^{b}
	49 d	2.968	12.23	8.61^{a}
SEM		0.01	0.05	0.05
			Probabilities	
Program		0.0001	0.0001	0.0001
Age		0.0001	0.0001	0.0001
Program*Age		0.8162	0.4176	0.0032
Main Effects				
Program	HP	2.910^{a}	11.29^{a}	7.63
	MP	2.896^{a}	10.95^{b}	7.15
	LP	2.822^{b}	10.60^{c}	6.73
Age	42 d	2.723^{g}	9.36^{g}	5.52
	43 d	2.763^{fg}	9.62^{f}	5.98
	44 d	2.806^{ef}	10.47	6.59
	45 d	2.870^{d}	10.71^{de}	6.93
	46 d	2.908^{cd}	11.12^{c}	7.25
	47 d	2.939^{bc}	11.67^{b}	7.96
	48 d	2.974^{ab}	12.21^{a}	8.43
	49 d	3.022^{a}	12.39^{a}	8.69

^{abcdefg} Means within columns with no common superscripts differ significantly (P < 0.05)

the HP males were leaner. Total breast thickness was the greatest (P<0.05) for HP and the lowest (P<0.05) for LP males. The breast muscle thickness of HP males was superior (P<0.05) to those of the MP and LP that had similar (P>0.05) MT. Total breast thickness kept increasing (P<0.05) up to 49 d of age, but there was no difference (P>0.05) between the MT at 48 and 49d, and between 48 and 47 d of age. In a previous study [12], there was » 36 % difference between the MT at 42 and 49 d of age. In this study, both MP and LP males showed similar differences (34 %) to the previous report in MT between 42 and 49 d of age. However, the HP reduced this gap to 26 % in the male ducks. At 49 d of age, the HP improved the muscle thickness of males by 11 and 14 % compared to MP and LP, respectively. The muscle thickness of HP males at 45 d of age was only 4 and 1.5 % less than those of MP and LP males at 49 d of age, respectively (Table 5). So far, duck producers are not paid for the quality of the carcass, but rather for the carcass weight with a relatively acceptable breast muscle development such as the one observed in the MP and LP birds at 49 d of age. This indicates that increasing the dietary protein resulted in early development of the breast muscle enough to send these birds to market, especially because they have reached the conventional market weight (> 3.200 kg) at 45 d of age. The possibility of reducing the growth period of these birds may represent a considerable economical profit in terms of flock turnover or feed conversion [4, 11].

The effects of dietary protein program on daily body weight and ultrasound measurements of female ducks from 42 to 49 d of age are presented in Table 6. These data included 50 birds per dietary program per age. There was no significant interaction between dietary program and age for body weight and TOT, but the interaction for MT was significant. Similarly to males, the difference in body weight between HP and MP females was not significant, but both were heavier (P<0.05) than the LP females. The TOT of the females increased significantly with increasing dietary protein. Both body weight and TOT of females on all programs improved up to 48 d of age. Within each program, there was a positive association between MT and age. However, the MT of the HP, MP, and LP females stopped increasing at 47, 48, and 49 d of age, respectively. At 42, 43, 44, and 45 d of age, HP females had significantly greater MT than the females on the other programs. There was no significant difference in MT of the females between the three dietary programs at 49 d of age. While the difference in MT between 42 and 49 d of age was 39 and 40 % for MP and LP, respectively, that difference was only 30 % for HP. However, the MT of HP females at 45 d still lagged behind those of MP and LP at 49 d by 14 and 13 %, respectively. Females seem to require more time rather than dietary protein for the development of the breast muscle probably because of their slower growth rate than males.

Body weight of males was significantly greater than females for HP, MP and LP (Figure 1) from 42 to 49 d. However, the difference between the males and females receiving high dietary protein was greater than that between the males and females receiving either medium or low protein. This difference was mainly due to the superior performance of males, but not females, on high dietary protein. However, that difference was not associated with a similar difference in breast muscle thickness which was similar in males and females receiving HP, MP, and LP (Figure 2). Female broiler chickens had significantly greater breast muscle yields than males when slaughtered at similar body weights [21].

Plasma Uric Acid and Total Protein from 42 to 49d: Plasma uric acid is considered an indication of the protein quality in the feed and its utilization and responds readily to different dietary protein levels [22]. Within each dietary program, the difference in plasma uric acid concentrations may reveal the efficiency of the protein utilization at each of the four days of measurements during wk 7. Plasma uric acid of HP males declined (P < 0.05) from 42 to 45 d, and that of MP and LP males increased (P < 0.05) to a level similar (P > 0.05) to that of HP at 42 d (Figure 3). From 45 to 49 d, plasma uric acid concentrations of MP and LP males declined (P < 0.05) to a concentration similar (P > 0.05) to that of HP males at 45 d. This may indicate that the efficiency of protein utilization in the males receiving HP was seen earlier than in those receiving either MP or LP.

Plasma uric acid of females declined from 42 to 45 for the three dietary programs (Figure 4). While there was no difference (P > 0.05) in the uric acid concentrations between 45 and 48 d of HP and MP, the concentration of LP females was significantly higher at 48 than at 45 d, but declined again at 49 d (Figure 4).

Dietary protein did not affect total plasma protein in males and females (Figures 5 and 6). This observation in Pekin ducks does not agree with that reported in growing chickens where increasing dietary protein resulted in an increase in plasma protein [23]. At 42 d, plasma protein concentration of both males and females was lower than at 45 d, and similar to 48 d concentration; the concentration at 49 d was the highest among the four days of measurements. Total plasma protein was considered as an indication of total protein reserves in an animal [24], and it was suggested that gluconeogenesis may result in a depression in total plasma protein that may be used to assess dietary inadequacies [25]. The blood parameters in the current data were not conclusive regarding dietary protein sufficiency as there were no significant differences among the three different levels of dietary protein.

Conclusion: Current trends in consumer demands have promoted the selection of animals with improved carcass parts that contribute more to edible meat and less fat. The breast meat is the most important part of a bird carcass, and selection for this trait employed many techniques including ultrasound scanning. A correlation of 0.73 was found for the ultrasound measurement and the breast meat yield in this study that included males and females receiving three different dietary protein programs. Collectively, male Pekin ducks selected for greater breast muscle thickness responded more efficiently than females to increasing dietary protein. The high dietary protein program contributed to the early development of breast muscle of males at market weight. This observation may be of considerable economical importance for producers in terms of flock turnover and feed conversion efficiency. The correlation coefficients presented herein indicate the relationship of different carcass components and in vivo measurements done by ultrasound. The carcass of ducks raised on HP program contained significantly more protein and less fat than the MP and LP feeding programs. This is a direct benefit for the consumer.

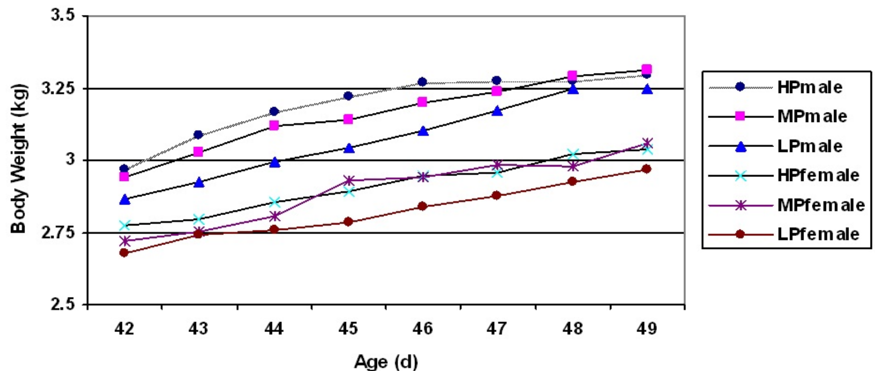

Fig. 1: Body weight of male and female pekin ducks from 42 to 49 d of age fed high (HP), and low (LP) protein diets.

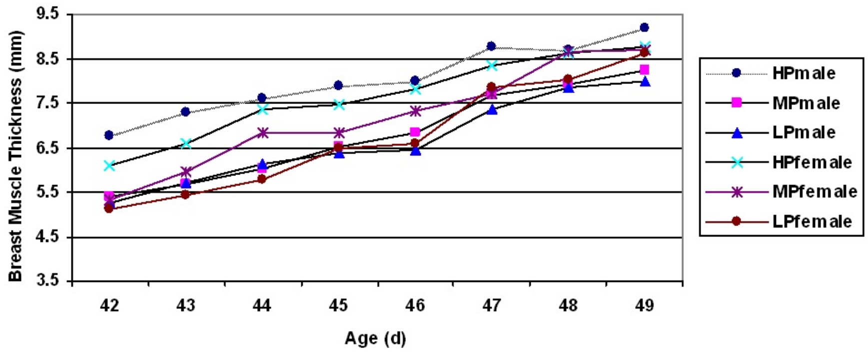

Fig. 2: Breast muscle thickness of male and female pekin ducks from 42 to 49 d of age fed high (HP), medium (MP) and low (LP) protein diets.

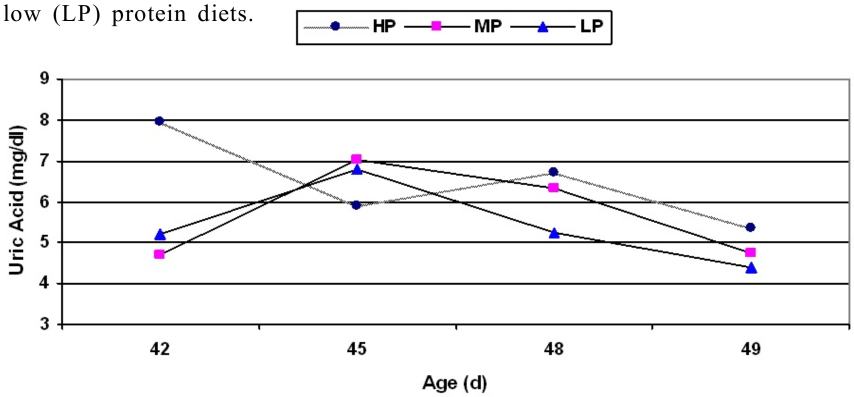

Fig. 3: Plasma uric acid of male pekin ducks from 42 to 49 d of age fed high (HP), medium (MP) and low (LP) protein diets.

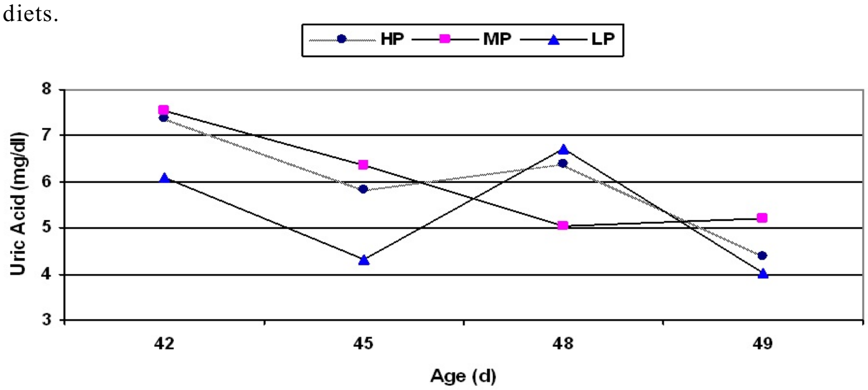

Fig. 4: Plasma uric acid of female pekin ducks from 42 to 49 d of age fed high (HP), medium (MP) and low (LP) protein diets.

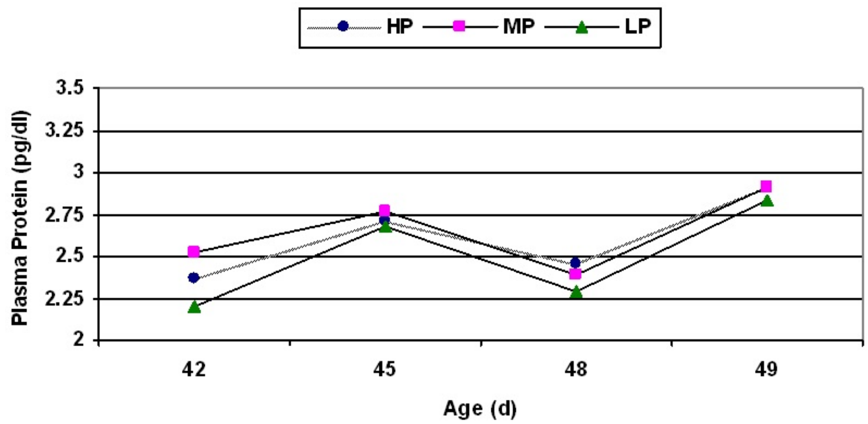

Fig. 5: Plasma protein of male pekin ducks from 42 to 49 d of age fed high (HP), medium (MP) and low (LP) protein diets.

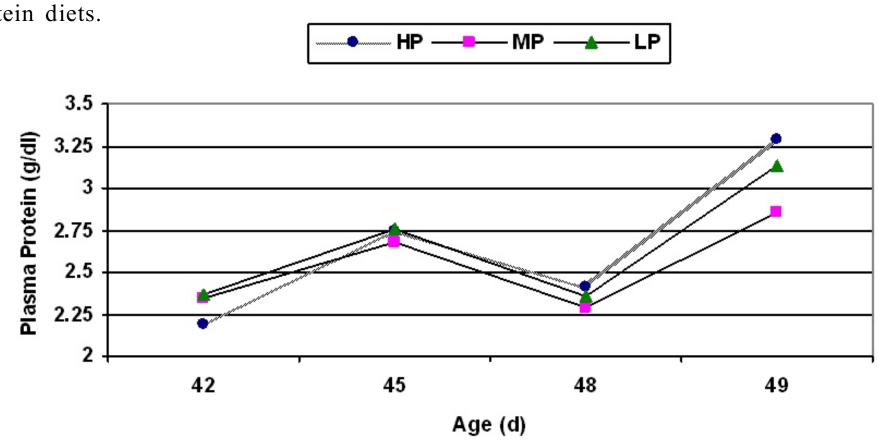

Fig. 6: Plasma protein of female pekin ducks from 42 to 49 d of age fed high (HP), medium (MP) and low (LP) protein diets.

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