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Measurement of Carcass and Chemical Parameters For Meat Yield and Quality Analysis of Rabbits: A Systematic Search For Alternative Source of Complete Protein

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Abstract: Meat is the major source of complete proteins essential for body growth and function. The annual production of meat in Bangladesh is not at all sufficient to fulfill the recommended dietary allowance of protein for every person. Therefore, we must seek for alternative sources of meat to solve this ever increasing food-related crisis. Rabbits are small mammals that have immense potential to be an alternative source of meat due to their short generation interval, rapid growth rate and low cost involvement. In the present study, we have measured various carcass and chemical parameters of three rabbit varieties, New Zealand Black (NzB), New Zealand White (NzW) and New Zealand Red (NzR), taken from opposite sexes of two different age-groups (1 year and 2 years) to choose the appropriate variety, sex and age of rabbits for meat production. Meat protein content was significantly higher in the rabbits from 1 year age-group than those from 2 years age-group, irrespective of variety and sex. Conversely, total lipid, total cholesterol and moisture contents were significantly lower in the rabbits of 1 year age-group. The protein content of male rabbit meat was higher; however the total lipid and cholesterol contents were lower than those of the female rabbits. Thus, the one year aged rabbits are suitable than two years for meat yield and quality and the quality of male rabbit meat is superior to female rabbit meat. NzR variety appears to be the best variety for meat production, irrespective of age and sex. Altogether, these findings indicate that 1 year old male NzR rabbit may be used for better yield and quality of meat production.

Key words: Rabbits · Meat Quality · Carcass Composition · Alternative Meat Source

INTRODUCTION

Meat is the edible flesh of animals which acts as one of the major sources of complete proteins essential for body growth and function. The domestication of animals allowed the systematic production of meat and the breeding of animals to improve meat production [1]. With the fragile state of economy, Bangladesh depends predominantly on agriculture to meet the gigantic task of feeding about 160 million people. The major sources of meat in this country are fishes, poultry, cattle, goat and lamb. However, the annual production of meat from all these sources is not at all sufficient to fulfill the recommended dietary allowance (RDA) of protein for every person in Bangladesh. Hence, all the reasonable options must be considered and evaluated to maximize food production in a developing country like Bangladesh.

Rabbits are small herbivorous mammals of the family Leporidae, used as food meat in Europe, South America, North America, some parts of the Middle East and China. All the rabbits throughout the world belong to the same species, *Oryctolagus cuniculus* [2]. Characteristics such as small body size, short generation interval, high reproductive potential, rapid growth rate, genetic diversity and the ability to utilize forages and by-products as major diet components make rabbits particularly suitable as meat producing small livestock in Bangladesh. They reach sexual maturity at the age of 4-5 months and regularly conceive litters of up to seven young, often doing so four or five times a year due to the fact that a rabbit's gestation period is only 28 to 31 days. Rabbit meat is of high quality as it contains high proportion of protein, low cholesterol, appropriate amount of vitamins and minerals [3- 5].

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Meat total cholesterol level in rabbit is much lower than chicken, turkey, beef and pork [6]. The rabbit m eat is all white meat, easily digestible and suitable for the patients. There are few, if any, cultural biases or religious prohibitions against the consumption of rabbit meat. If the rabbit meat can be introduced in our country, the scarcity of meat may be reduced. So, in the present study, we have measured various carcass and chemical parameters of three rabbits varieties (NzB, NzW and NzR) of opposite sexes and of two different age-groups (1 year and 2 years) to choose the appropriate variety, sex and age of rabbits.

MATERIALS AND METHODS

This study was conducted at the Research laboratories, Department of Biochemistry and Molecular Biology, Jahangirnagar University and Nutrition Analysis Laboratory, Poultry Production and Research Division, Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka.

Rabbits: A total of 48 rabbits, 4 from each of 3 different varieties (NzR, NzB and NzW) of opposite sexes and different age-groups (1 year and 2 years) were analyzed for this study. The animals were reared in individual cages with standard feeding and management (food and water *ad libitum*). First, we divided the study animals into 2 groups based on their age. Group 1 consisted of a total of 24 one year-aged rabbits, 4 from each sex group of the three varieties (NzW, NzR and NzB). Similarly, group 2 consisted of a total of 24 two years-aged rabbits, 4 from each sex group of the three varieties (Figure 1).

Measurement of Carcass Parameters: The parameters such as live body weight; dressed weight; breast meat weight; and arm/thigh meat ratio were considered for the measurement of carcass yield characteristics. Live body weights of all the rabbits were measured. Following the slaughtering, all the animals were dressed (removal of head, skin and all visceral organs). Dressed weight of each animal was measured and expressed as percent by using the following formula [7]:

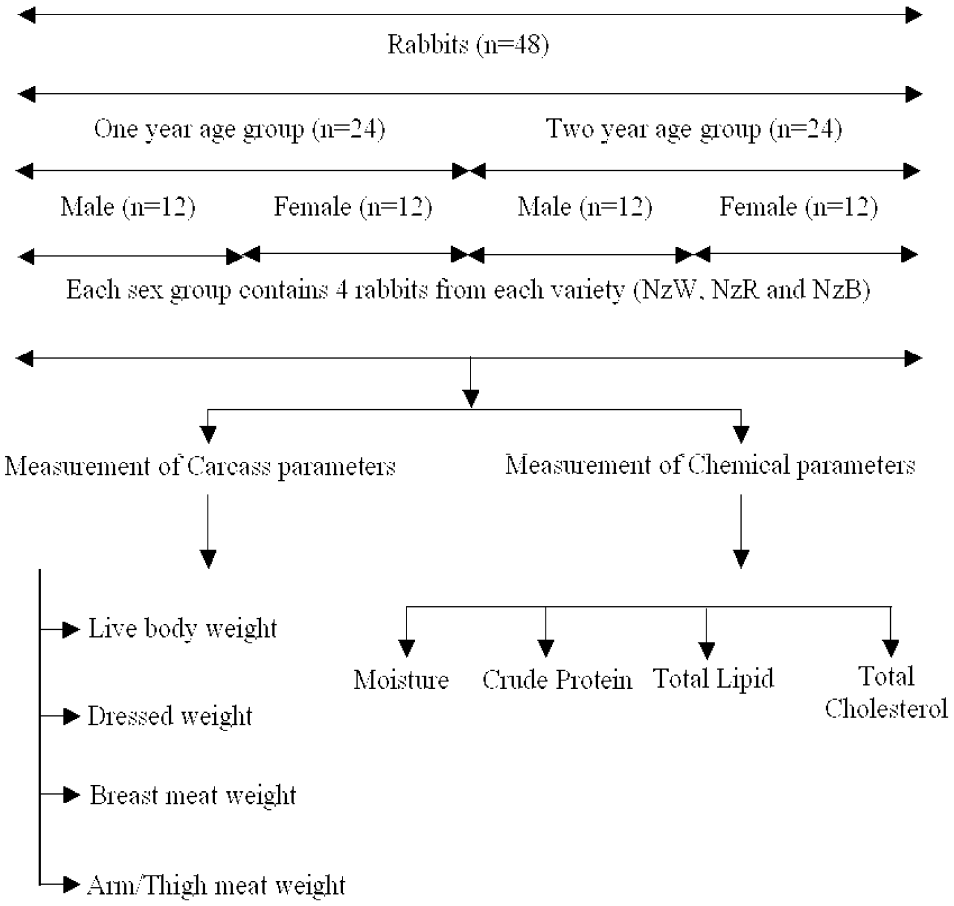

Fig. 1: Experimental design for rabbit meat yield and quality analyses

Dressed weight (%) = (Dressed weight / Live body weight) × 100.

Different parts of rabbits' bodies were also weighed and expressed as above.

Measurement of Chemical Parameters: After measuring the carcass parameters, fresh meat from the breast and thigh of each rabbit was collected and combined in duplicate. Then each combined meat sample was chopped and minced using a chopper machine. Then each of these minced meat samples was packed in sufficient amount in zipped poly-bags for measuring chemical parameters such as moisture; crude protein; total lipid and total cholesterol. All the samples were stored at -20°C freezer throughout the experiment.

Measurement of Meat Moisture Content: Washed crucibles were dried at 100°C and cooled in desiccators. Then we took the weight of dried crucibles and added 2g of the meat in duplicate into each crucible for each sample. The crucibles were put inside the oven at 135°C for 2 hours. The moisture content (%) was measured by using the following formula [8]:

$$\text{Moisture content (\%)} = \{(A+C-D)/C\times 100$$

Whereas, A = Weight of dried crucible; C = Sample weight; D = Weight of crucible and sample after drying.

Measurement of Meat Protein, Total Lipid and Cholesterol Contents: Meat crude protein content was measured by Kjeldahl's method [8, 9]. Meat total lipid content was determined by using the methanol:chloroform (2:1) extraction method as described by Folch *et al.* [10]. Total lipid indicates all the constituents of lipid such as free fatty acid, triglycerides, phosphatidylcholine, phosphatidylethanol amine, cholesterol etc. After measuring the meat total lipid, 1 ml of total lipid solution was used to measure the total cholesterol content by the cholesterol oxidase assay [11, 12] using commercially available reagent kits (Human GmbH-Germany).

Measurement of Serum Total Cholesterol Level: Serum cholesterol level was determined by the cholesterol oxidase assay [11, 12] using commercially available reagent kit (Human GmbH-Germany).

Statistical Analysis for Carcass and Biochemical Parameters: All the collected data were tabulated, computed and analyzed by CRD using computer software (Statistical package for Social Science version-12). Means were compared for significant differences using Duncan's Multiple Range Test and a level of $P<0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Carcass Parameters Analysis for Meat Yield: There was significant age and variety related differences of body weight gain of the rabbits, irrespective of sex. Dressed weight (%) significantly differed among the varieties, irrespective of sex and age. Dressed weight was highest in NzR, intermediate in NzW and lowest in NzB. We did not find any significant age and sex-related differences in dressed weight among the rabbits. In case of breast meat weight gain, there was no significant variety, sex or age-related differences. The breast meat weight (%) in rabbits from 1 year age-group was higher than those from 2 years age-group. In case of arm-thigh meat weight ratio, we observed a significant sex-related difference, irrespective of variety and age (Table 1). In our carcass quality study, it was found that one year-aged rabbits are suitable than that of two years-aged for meat production and NzR male rabbits are the best meat producers among the tested varieties.

Differences in meat moisture content among the rabbits: We did not find any variety related differences on meat moisture content (%) irrespective of the sex or age. However, a highly significant ($P<0.01$) age and sex-related difference on the meat moisture content was observed, irrespective of the variety and sex as well as variety and age, respectively. The moisture content was significantly higher in the rabbits from 2 years age-group than those from 1 year age-group, irrespective of variety and sex. Meat moisture content was also significantly higher in the female rabbits than that of male rabbits, irrespective of variety and age (Table 2).

Variation in Meat Crude Protein Content: We observed significant age-related differences on the crude protein content (%) showing a decrease of crude protein content with increasing age, irrespective of the variety or sex. However, there was no significant variety-related or sex-related difference on the meat protein content in rabbits. We found that the meat crude protein content was significantly ($P<0.01$) higher in the rabbits from 1 year age-group than those from 2 years age-group, irrespective of variety and sex (Figure 2). Among the three varieties of rabbits, the one year aged NzR male has the highest protein content (Table 2).

Table 1: Analyses of carcass parameters for growth and meat yield of rabbits

			Variety				Level of significance		
Parameters	Age	Sex	NzW	NzR	NzB	Mean	Variety	Sex	Age
Live body weight (g)	1 Year	Male	1925.0± 35	1985.0± 21	1986.0± 18				
		Female	1945.0± 35	1975.0± 35	1990.0± 14				
		Mean	1935.0± 31	1980.0± 95	1988.0± 21	1967	10.26*	0.218^{NS}	36.76**
	2 Year	Male	1945.0± 25	1825.0± 35	1966.0± 14				
		Female	1905.0 ± 7	1850.0± 28	1970.0± 35				
		Mean	1920.0± 31	1837.0± 79	1978.0± 34	1911			
Dressed Weight (%)	1 Year	Male	85.0±1.4	88.7±2.8	80.4±0.5				
		Female	86.0±0.7	87.5±1.4	81.5±6.0				
		Mean	85.5±2.2	88.1±0.9	80.9±5.7	84.84	33.09**	0.854^{NS}	0.47^{NS}
	2 Year	Male	88.5±1.4	88.0±0.7	82.1±3.4				
		Female	87.5±0.7	88.1±1.4	79.0±0.0				
		Mean	88.0±1.3	88.1±0.9	80.6±1.5	85.53			
Breast meat weight (%)	1 Year	Male	4.0±0.0	4.4±0.0	4.7±0.0				
		Female	4.0±0.0	4.4±0.0	4.4±0.0				
		Mean	4.0±0.2	4.4±0.2	4.6±0.3	4.31	-	-	-
	2 Year	Male	4.4±0.0	4.1±0.0	4.1±0.0				
		Female	4.2±0.0	4.1±0.0	4.2±0.0				
		Mean	4.3±0.1	4.1±0.2	4.2±0.1	4.18			
Arm/Thigh meat weight (%)	1 Year	Male	14.0±0.0	16.0±0.0	18.0±0.4				
		Female	17.0±0.0	14.0±0.0	15.0±0.4				
		Mean	15.5±0.6	15.0±0.3	16.5±0.4	16	3.97ns	22.61**	0.94^{NS}
	2 Year	Male	15.0±0.0	13.0±7.1	14.0±0.0				
		Female	13.0±0.7	14.0±0.1	16.0±0.1				
		Mean	14.0±0.5	13.5±0.3	15.0±0.4	14			

Here, * = P<0.05; ** = (P<0.01) and ns= non-significant.

Table 2: Analyses of chemical parameters for rabbit meat quality assessment

			Variety				Level of significance		
Parameters	Age	Sex	NzW	NzR	NzB	Mean	Variety	Sex	Age
Moisture (%)	1 Year	Male	60.7±.21	65.1±0.5	64.0±7.1				
		Female	63.5±.25	68.2±.00	68.8±.13				
		Mean	62.1±1.4	66.6±1.6	66.4±2.8	65.04	177.60^{NS}	934.45**	98.65**
	2 Year	Male	68.8±7.1	68.1±0.5	70.7±8.5				
		Female	68.1±.71	70.2±0.2	66.6±0.4				
		Mean	68.5±.42	69.1±1.9	68.7±2.4	68.75			
Crude protein (%)	1 Year	Male	31.2±2.8	36.6±2.8	30.9±2.1				
		Female	30.9±2.8	33.5±0.5	28.9±0.2				
		Mean	31.1±.16	35.0±1.5	29.9±1.2	31.97	3.66^{NS}	153.89**	2.96^{NS}
	2 Year	Male	27.0±.41	26.7±.27	28.3±0.4				
		Female	27.4±.48	25.0±.28	31.0±0.0				
		Mean	27.3±.35	25.9±1.9	29.7±1.6	27.59			
Total lipid	1 Year	Male	19.0±1.4	14.0±1.4	17.0±1.4				
		Female	20.0±1.4	16.0±1.4	20.0±2.8				
		Mean	19.5±1.3	15.0±1.6	18.5±2.5	17.66	16.16**	2.72^{NS}	6.72^{NS}
	2 Year	Male	20.0±1.4	15.0±1.4	19.0±1.4				
		Female	22.0±1.2	17.0±1.4	20.0±2.8				
		Mean	21.0±1.6	16.0±1.6	19.5±1.9	18.83			
Total cholesterol	1 Year	Male	57.0±0.0	56.0±0.0	58.0±1.4				
		Female	60.0±2.8	60.5±7.5	62.0±2.8				
		Mean	58.5±2.4	58.3±2.3	60.0±2.9	58.91	2.93^{NS}	1.21^{NS}	16.85*
	2 Year	Male	58.0±1.4	58.0±1.4	60.0±0.0				
		Female	60.0±1.4	60.5±.71	61.0±2.8				
		Mean	59.0±1.6	59.2±1.7	60.5±1.7	59.56			

Here, * =P<0.05; ** = (P<0.01) and NS= Non-significant.

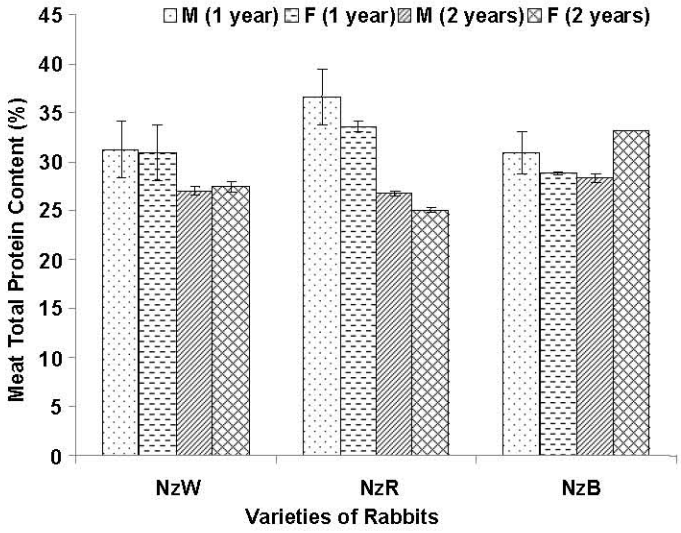

Fig. 2: Meat total protein content of rabbits from different age and sex group among the three tested varieties. Here, NzB = New Zealand Black; NzW=New Zealand White; NzR = New Zealand Red.

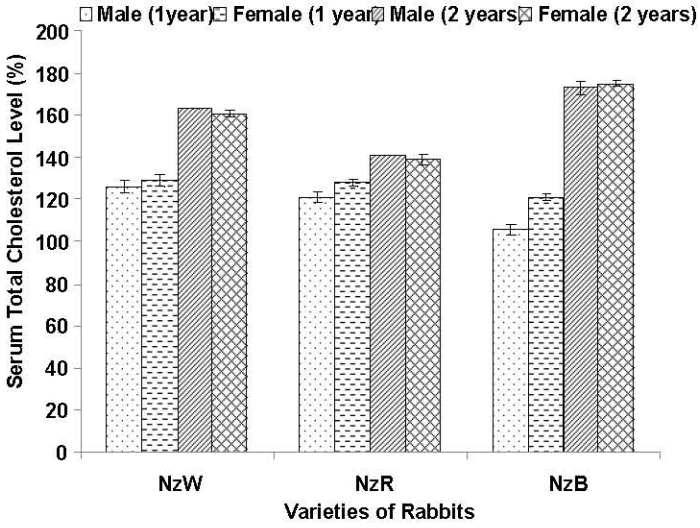

Fig. 3: Serum total cholesterol level of rabbits from different age and sex group among the three tested varieties. Here, NzB = New Zealand Black; NzW=New Zealand White; NzR = New Zealand Red.

Variation in Meat Total Lipid Content: We did not find any significant age or sex-related difference in the meat total lipid content (%). However, a significant ($P<0.01$) difference of meat total lipid content was observed among the varieties of rabbits, irrespective of their sex or age. Among all the rabbits, meat total lipid content was lowest in male NzR variety of 1 year age-group, whereas highest in female NzW variety of 2 yrs age-group (Table 2).

Differences in meat and serum total cholesterol Content: We observed a significant ($P<0.05$) sex-related difference of meat total cholesterol content (%) among the rabbits, irrespective of their variety or age. On average, the cholesterol content in meat of one year age-group is lower than that of two years age-group. NzR male rabbit meat contained the lowest content of total cholesterol among all the groups (Table 2). In case of serum total cholesterol level, we observed a significant ($P<0.05$) age-related difference among the rabbits, irrespective of their variety or sex (Figure 3).

Our study suggests that one year-aged rabbits have the higher protein %, lower lipid and cholesterol % than the two years aged rabbits. Male rabbits have the lower lipid content than female. Altogether, these findings indicate that 1 year old male NzR rabbit may be used for better yield and quality of meat production.

The rabbit meat has lower lipid and cholesterol contents, higher protein content than other conventional meat sources [13, 14]. Lukefahr (1990) reported that, Cholesterol level in rabbit meat is much lower than chicken, turkey, beef, pork [6]. Nizza and Moniello (2000) also reported that rabbit meat is rich in protein and low in lipid and cholesterol [15]. Thus, in a number of respects, the major potential for rabbit production seems to be in developing countries like Bangladesh, where the needs for maximizing food production are greatest. So, in short, rabbit breeding has a bright future in Bangladesh. However, proper cautions should be taken to avoid several health issues associated with the use of rabbits for meat, such as "rabbit fever", "rabbit starvation" etc [16]. Further research should be done for the feeding system development, meat quality and popularization of meat, economic impact for rabbit rearing in the rural conditions of Bangladesh.

This study suggested that the one year aged rabbits are suitable than two years for meat yield and quality and the quality of male rabbit meat is superior to female rabbit meat. NzR variety appears to be the best variety for meat production, irrespective of age and sex and 1 year old male NzR rabbit may be used for better yield and quality of meat production.

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