

# Morphological Characteristics of F1 Generation (Mohini) crossbred ducks produced by crossing of Vigova Super M Drakes with Pati Ducks

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## ABSTRACT

The study was conducted at Govt. Duck and Poultry Farm, Joysagar, Sivasagar district of Assam with the objective to develop a meat type duck variety by crossbreeding Vigova Super M Drakes with Pati Ducks. The resulting F1 Generation Ducks were studied for their phenotypic characteristics in comparison to their parent line. The Body Weight of the F1 generation Duck were studied in comparison to their parent line. The F1 generation were also fed different ration along with different housing conditions. Different body measurements were also studied along with their coat colour. The F1 generation showed marked increase in body weight in comparison to Vogova Super M duck and Pati Duck. Moreover the F1 generation fed on broiler ration and housed in field condition showed marked increase in body weight in comparison to the duck fed with Layer ration and ducks kept in farm condition. The different body measurement shows the male to be superior to the females in different parameters with different coat colour. The major colour pattern of bill, shank and feet was found to be yellow, whereas skin was mostly white in colour and plumage colour pattern found to be white, black and brown in different parts of the body.

*Key words:* Pati duck, Cross bred, Vigova Super M, Morphological character

## Introduction

Ducks occupy an important position next to chicken farming in India. They have economic, social and ecological value. They form about 10% of the total poultry population and contribute about 6-7% of total eggs produced in the country. Ducks are considered as the most preferred poultry after chicken, also known to possess unique disease resistance and adaptability. Nutrient composition of duck meat and eggs are comparable to that of chicken (Tai and Tai, 2001). Duck farming is a major component in integrated farming system and plays a significant role

in women empowerment and upliftment of socio-economic status of the farming community of Assam. Due to hot-humid climatic condition of Assam along with extensive availability of resources like ponds, river, marshy wet lands etc. provides a suitable natural habitat for duck rearing in rural areas of the states. The production potential of the desi duck widely known as "Pati hanh" is very poor. They are good forager, hardy with higher survivability rate in rural condition. Duck eggs and meats are widely accepted by different sections of the society and plays a vital role to fulfill nutritional security. Meat and eggs from ducks are good dietary

sources of high quality protein, energy and several vitamins (vitamin A, C, E, K, B2, B6, B12) and minerals such as calcium, iron, magnesium, sodium, manganese, copper and zinc (Lorenzo *et al.*, 2011). The people of Assam are mostly shown their keen interest in duck husbandry to meet their demands for meat and egg as a source for animal protein. Assam state has 73 lakhs of duck population (As per the 19<sup>th</sup> livestock census). Sivasagar district, with a duck population of 12 lakhs is the topmost district in Assam. With 90% of human population being non-vegetarian, duck meat is widely consumed in this region. The physiological condition of Assam with its naturally rich wetland, marshes, rivers, ponds, swamps, streams etc. provides an ideal condition for easy rearing of duck. Duck meat is one of the most relished meat in Assam. But, the meat quality of local duck breed 'Pati' is very low and its dressing percentage is very high. Hence, there is a need for upgradation of the local 'Pati' ducks for better meat yield, both qualitative and quantitative. In the other hand the Pekin (Vigova Super M) duck which is from the Mallard breed is the most commonly farmed duck in the UK and originates from China. White Pekin is the most popular duck in the world known for table purpose. It is fast growing and has low feed consumption with fine quality of meat. It attains about 2.2 to 2.5 Kgs of body weight in 42 days of age, with a feed conversion ratio of 1:2.3 to 2.7 Kgs. This experiment aims at developing a meat type duck variety by crossing the local 'Pati' duck with 'Vigova Super-M' drake in a control environment and introduce it to field for sustainable meat yield.

## Materials and Methods

The study was conducted at Govt. Duck and Poultry Farm, Joysagar, Sivasagar, Assam and ducklings were hatched at the Hatchery unit present at the farm premises. Vigova Super M ducks and Pati ducks were reared together from duckling's stage onwards. After 8th weeks of age when the body colour pattern were markedly visible, they were divided into 5 groups according to the coat colour of Pati Ducks (Black and white colour, Whitish light brown colour, Blackish brown colour, Khaki colour and White colour) and Vigova Super M male (Drakes) showing superior body contour such as breast angle and greater neck length were introduced into each group of pati ducks at a male fe-

male ratio of 1:4 for Pen Mating. The eggs laid were incubated in the farm incubator for the production of F1 Generation Ducks.

The resulting ducklings (F1 Cross Breds) were subjected to further study at farm as well as in field conditions. They were given ad libitum commercially purchased feed. Starter feed were been given upto one (01) month of age. Thereafter grower feed were been given upto 06 weeks of age and lastly finisher feed were been given from 6<sup>th</sup> week of age upto 8<sup>th</sup> week of age. Body weight were been measured at Day One followed by weekly body weight measurements upto 8th week of age. All ducks were farmed under the same conditions. All ducks received ad libitum feed from day one onwards. The ducks were weighed every week on an empty stomach before feeding in the morning. The study was completed at the end of eight weeks. The F1 generation ducks kept in field condition were kept in semi-intensive system and they were also been given ad libitum feed and fresh drinking water.

## Parameters measured

In the study, the different body measurements were taken at the end of eight weeks. The following parameters were measured:

**Body weight:** This was taken with a sensitive top loading scale of 5000g capacity at day-old and at weekly intervals. **Bill length:** This was measured as the distance between the tip of the bill and rear end of the beak. **Bill width:** This was measured over the point of nostrils. **Head length:** This was measured as the distance between rear end of bill and condyle occipital. **Neck length:** This was measured as the distance between the first and last cervical vertebrae. **Breast length:** This was measured between the anterior and the posterior border of the breast-bone crest. **Body length:** It was measured as length of the body from the base of the bill to the tail near the uropygial oil gland. **Wing span:** This was measured as the distance from the shoulder joint to the extremity of the terminal phalangx. **Body circumference:** This was measured as the circumference of the body under the wing through the anterior border of the breast bone crest and the central thoracic vertebrae. **Shank length:** This is the distance from the hock joint to the extremity of the digitus pedis. **Thigh length:** This is the distance from the knee joint to the hock joint.

All linear body parameters were taken with a tai-

lor tape in centimeters. The birds were closely observed for distribution of colour pattern in Bill, Eye and Eyelid. Plumage colour pattern in all part of the body (Head, Neck, Wing, Back, Tail, Thigh and Breast) were identified and documented by visual observation for the present study.

## Results

Table 1 show the mean growth performance based on the body weight gain of the three different breeds of ducks. Significant differences were observed in final body weight gain. Pati duck day old ducklings had a body weight of  $0.039 \pm 1.09$  kg, whereas in the case of Vigova Super M duck and the F1 generation ducks they showed day old ducklings' body weight of  $0.042 \pm 0.56$  kg and  $0.042 \pm 0.12$  kg respectively which shows a similar body weight in comparison to pati ducks day old ducklings. Whereas the weekly body weight gain in case of Vigova Super M Ducks and the F1 Generation Duck shows marked increase in body weight in comparison to the Pati Ducks. Significant increase in the body weight can be observe from 6th week of age onwards in case of the Pekin and F1 generation ducks in comparison to the pati ducks, whereas the F1 generation showed marked increase in body weight on 7th week ( $1.401 \pm 0.14$  kg) in comparison to Pekin Duck ( $1.221 \pm 0.65$  kg) and on 8th week F1 generation showed body weight of  $1.776 \pm 0.25$  kg in comparison to Pekin Duck which showed a body weight of  $1.390 \pm 0.58$ kg. The marked increase in body weight in case of F1 generation Ducks may be due to Hybrid Vigour. Solomon *et al.* (2006); Perez (1985) and Holderread, (1978) reported higher values for body weight in Pekin and Muscovy ducks respectively.

These values were higher than 1.502 kg and 1.358 kg obtained in the present study for body weight at 12 weeks in male and female Aylesbury ducks. The difference could be attributed to genetic factors, which portrayed the Aylesbury ducks as inferior meat breed to Pekin and Muscovy.

Table 2 shows the weekly body weight of the F1 generation ducks when kept in different housing conditions and also fed with different rations. The first group shows the weekly body weight of duck kept in farm condition (Intensive System) and been fed layer ration. They show a body weight of  $1.776 \pm 0.25$  kg at 8<sup>th</sup> weeks of age, whereas duck kept in field condition and fed layer ration shows a body weight of  $1.926 \pm 1.54$  kg. The ducks kept in field condition (semi-intensive system) and fed broiler ration show a marked increase in body weight from 4<sup>th</sup> week onwards in comparison to the other two groups. At 8<sup>th</sup> weeks of age the group fed broiler ration shows a body weight of  $2.380 \pm 1.84$  kg which far higher than the body weight of the previous two groups. In terms of the performance, body weight of crossbred F1 generation ducks was higher than other breeds irrespective of the higher initial body weight of crossbred. It means that initial weight does not have any relation to the growth potential of crossbreds. Overfeeding can cause a dramatic increase in body weight (Zanusso *et al.*, 2003). Most studies suggested that overfeeding had a positive effect on growth performance in waterfowl (Fournier *et al.*, 1997; Su *et al.*, 2009). This study found similar results.

The different body measurement of male and female ducks are shown in Table 3, 4, 5 and 6 based on their grouping with similar coat colour. On an average both male and female doesn't show much of a

**Table 1.** Average weekly body weight of Pati Duck, Vigova Super M Duck and F1 Generation Ducks

Sl. No.	Age	Breeds		
		Average Body Weight of Pati Duck (in kg)	Average Body Weight of Vigova Super M Duck (in kg)	Average Body Weight of F1 Generation Ducks (in kg)
1	DOD	0.039±1.09	0.042±0.56	0.042±0.12
2	1 <sup>st</sup> week	0.065±0.07	0.067±0.37	0.067±0.55
3	2 <sup>nd</sup> week	0.123±0.45	0.136±0.49	0.133±0.12
4	3 <sup>rd</sup> week	0.233±0.68	0.275±0.10	0.271±0.36
5	4 <sup>th</sup> week	0.353±0.22	0.421±0.73	0.414±0.78
6	5 <sup>th</sup> week	0.523±0.14	0.619±0.58	0.612±0.47
7	6 <sup>th</sup> week	0.803±1.01	1.024±0.45	0.996±0.16
8	7 <sup>th</sup> week	0.925±1.05	1.221±0.65	1.401±0.14
9	8 <sup>th</sup> week	1.243±0.66	1.390±0.58	1.776±0.25

difference in the body measurements. Though some differences can be observed in the wing span of the whitish light brown male in comparison to its female. The male shows a wing span of  $45 \pm 0.74$  cm, whereas the female shows a wing span of  $42 \pm 0.19$  cm. The average Bill length was found to be higher in case of the white coloured ducks showing an average of 9.4 cm as compared to the other groups of ducks. These measurements are much higher in comparison to that of the Pati Ducks and Drakes. Yakubu (2009) reported shorter bill length of 4.98 cm and 3.75 cm for African Muscovy male and female ducks. Another finding was recorded by Murugan *et al.*, 2009 in Sanyasi and Keeri variety ducks of India; they recorded the bill length of  $6.81 \pm 0.82$  and  $6.1 \pm 0.90$  cm respectively for both the variety. Another observation on the Bill length of desi ducks in west Bengal was  $5.25 \pm 0.04$  cm, reported by Vij *et al.*, 2010. Morduzzaman *et al.* (2015) also reported bill length of Nageswari ducks of Bangladesh were  $5.87 \pm 0.09$  and  $5.54 \pm 0.07$  cm in male and female respectively. The variation of bill length might be due to the difference in breed.

The bill width, head length and the head width are more or less same in case of male and female F1 generation ducks. The average Neck length recorded was more in white colored male ( $19.4 \pm 1.06$  cm) than that of female ( $19 \pm 1.61$  cm). The whitish light brown colored duck shows an average neck length of only  $16 \pm 1.36$  cm. Higher values of ( $23.49 \pm 0.58$  cm in males and  $21.59 \pm 0.49$  cm in females) were noted in Nageswari duck by Morduzzaman *et al.*, 2015 and lower value ( $13.47 \pm 0.25$  and  $12.90 \pm 0.22$  cm) Sanyasi and Keeri

variety of ducks by Murugan *et al.*, 2009.

Yakubu (2009) also recorded the mean neck length for male and female African Muscovy ducks as 18.10 cm and 14.33 cm respectively, while Murugan *et al.* (2009) recorded a higher value for the neck length of  $21.10 \pm 0.12$  cm and  $18.70 \pm 0.24$  cm for Sanyasi Drake and Ducks respectively. The difference in neck length might be due to the breed difference. The breast length (22 cm) and the body length (32 cm) are similar in both male and female duck in all the groups of ducks. Murugan *et al.*, 2009, reported the body length for Sanyasi and Keerivarieties was  $23.85 \pm 0.09$  cm and  $23.64 \pm 0.08$  cm respectively. On the other hand, Yakubu (2009) recorded mean values of body length for male and female African Muscovy ducks as 47.86 cm and 38.35 cm respectively. The lower valued obtained in this study might be due to the variation in the size and conformation of the distinct variety of ducks.

The shank length of F1 generation duck was recorded highest in case of white coloured ducks as male shows  $7 \pm 1.47$  cm and drake is  $7 \pm 1.05$  cm. Zaman *et al.* (2007) also recorded the mean shank length of male and female as  $6.67 \pm 0.71$  and  $6.12 \pm 0.68$  cm respectively for Nageswari ducks of Assam. Another report on shank length for Desi ducks of West Bengal was reported as 5.67 cm by Vij *et al.* 2010. The difference in the shank length of different varieties of ducks might be attributed to the variation in the genotype and environment where they were reared.

The sex significant difference in body measurements, with the males having higher weight and larger body dimensions than female ducks, has been

**Table 2.** Comparative study of average weekly Body Weight of F1 Generation Ducks fed on different rations and housing conditions

Sl. No.	Age	Average Body Weight of F1 Generation Ducks (in kg)		
		Group I In Farm Condition (Fed Layer Feed)	Group II In Field Condition (Fed Layer Feed)	Group III In Field Condition (Fed Broiler Feed)
1	DOD	0.042±0.12	0.042±1.01	0.042±1.66
2	1 <sup>st</sup> week	0.067±0.55	0.126±1.47	0.140±1.25
3	2 <sup>nd</sup> week	0.133±0.12	0.279±1.05	0.315±0.87
4	3 <sup>rd</sup> week	0.271±0.36	0.563±1.08	0.685±0.57
5	4 <sup>th</sup> week	0.414±0.78	0.831±0.09	1.030±0.25
6	5 <sup>th</sup> week	0.612±0.47	1.097±1.06	1.400±1.29
7	6 <sup>th</sup> week	0.996±0.16	1.422±0.08	1.700±1.45
8	7 <sup>th</sup> week	1.401±0.14	1.798±0.77	1.900±1.73
9	8 <sup>th</sup> week	1.776±0.25	1.926±1.54	2.380±1.84

**Table 3.** Comparative Study of body measurement of matured Ducks and drakes (in cm)

Sl. No.	Colour pattern	Breed of duck	Bill length	Bill width	Head length	Head width	Neck length	Breast length	Body length	Wing span	Body circumference	Shank length	Thigh length
1	Whitish light brown drake	VSM	10±0.25	5.5±0.48	10±0.59	10±0.65	20±0.78	24±1.05	35±1.58	46±1.77	36±1.69	7±1.47	9±1.74
2		Pati	6.16±0.25	3.9±0.14	6.33±1.25	6.33±1.58	15.67±1.23	18±1.74	30±0.59	43±0.47	30.67±0.49	5.67±1.45	8±1.25
3		F1	8±1.29	5±1.57	8±1.49	9±0.28	16±0.75	22±0.48	33±0.98	45±0.74	35±1.25	6±1.74	8.5±0.56
4	Whitish light brown duck	VSM	10±0.69	5±0.47	10±0.59	10±0.69	19±1.28	24±1.47	34±1.49	45±1.58	35±1.38	7±1.05	9±1.47
5		Pati	5.8±1.25	3.66±1.54	6.5±1.47	6.5±0.25	14±0.74	17.33±0.69	28±0.37	39.33±0.29	31.66±1.07	5.33±1.44	8.67±1.75
6		F1	8±0.65	5±1.47	8±1.54	9±1.77	16±1.36	22±1.47	32±0.27	42±0.19	35±0.37	6±0.74	8±0.14

**Table 4.** Comparative Study of body measurement of matured Ducks and drakes (in cm)

Sl. No.	Colour pattern	Breed of duck	Bill length	Bill width	Head length	Head width	Neck length	Breast length	Body length	Wing span	Body circumference	Shank length	Thigh length
1	Blackish brown drake	VSM	10±0.25	5.5±0.48	10±0.59	10±0.65	20±0.78	24±1.05	35±1.58	46±1.77	36±1.69	7±1.47	9±1.74
2		Pati	7.03±0.25	4.1±1.26	7.36±1.47	8.33±0.23	15.33±0.74	19.33±1.38	36.66±0.45	46.16±1.27	33±0.71	5.33±1.22	8.66±1.48
3		F1	9±0.25	5±0.14	9±0.99	9±1.45	18±0.78	22±1.25	32.5±1.47	47±1.36	36±0.25	6±0.24	8±1.45
4	Blackish brown duck	VSM	10±0.69	5±0.47	10±0.59	10±0.69	19±1.28	24±1.47	34±1.49	45±1.58	35±1.38	7±1.05	9±1.47
5		Pati	5.83±1.27	3.2±1.44	6.33±0.14	6.66±1.26	12.66±1.24	17.33±1.75	27±0.27	34±0.96	31.33±0.22	5.33±0.14	7.66±1.74
6		F1	8±1.25	5±0.24	8±0.44	9±0.29	18±1.24	22±1.64	32±1.73	43±0.25	35±0.14	6±0.77	8±0.26

**Table 5.** Comparative Study of body measurement of matured Ducks and drakes (in cm)

Sl. No.	Colour pattern	Breed of duck	Bill length	Bill width	Head length	Head width	Neck length	Breast length	Body length	Wing span	Body circumference	Shank length	Thigh length
1	Black & white drake	VSM	10±0.25	5.5±0.48	10±0.59	10±0.65	20±0.78	24±1.05	35±1.58	46±1.77	36±1.69	7±1.47	9±1.74
2		Pati	6.5±1.45	3.66±0.36	7±0.24	6.66±1.77	16.66±0.25	20±1.47	30.66±1.45	43.33±0.29	32.33±0.45	5.33±1.29	8.33±1.70
3		F1	8±1.25	4.9±1.47	8±1.26	9±1.34	19±0.25	21±1.24	32±1.55	44±1.04	35±1.24	6±0.75	8.5±0.47
4	Comparative Study of body measurement of matured Ducks and drakes (in cm)												
5	Black & white duck	VSM	10±0.69	5±0.47	10±0.59	10±0.69	19±1.28	24±1.47	34±1.49	45±1.58	35±1.38	7±1.05	9±1.47
6		Pati	5.83±1.22	3.66±1.41	7±1.36	6.5±1.84	15.33±1.25	19.33±1.24	28±0.25	42±0.76	30.66±0.28	5±0.74	8±0.25
		F1	8±1.27	4.9±1.39	8±1.27	9±0.77	18±0.28	21±0.14	32±0.22	44±1.44	35±1.25	6±1.24	8±0.36

reported in previous studies for example Baeza *et al.* (2001); Etuk *et al.* (2006); Kleczek *et al.* (2006); Ogah *et al.* (2009) and Yakubu (2009). These investigators were of the opinion that the variations in the gender might result from genetic composition in the population under consideration.

The most distinctive morphological characteristics in case of the F1 Generation duck is the presence of a concave marking above the eye which is light brown to whitish in colour and can be observed in the F1 generation. Also the distinctive dark greenish marking in the head region of the Pati duck are diminished in the F1 generation and only Blackish or whitish spots are observed in the head region. The head colour are distinctive of the group in which they were divided. Head colour differs from white to yellowish brown. Some of the duck shows greyish black to brownish black in colour. The Neck colour is somewhat similar to that of the head colour. Distinctive white spots can be seen the group comprising of black and white coat colour. Other parameters such as Wing, Back, Tail, Thigh, Breast colour are typical to their individual coat colour. The Bill Colour was found to be yellow in all the groups of ducks except in case of Khaki coloured female ducks which shows a brown coloured bill. The most common Eyecolour was Black and brown. The Eyelid colours were mostly black and brown. The feet colours were observed mostly yellow.

## Discussion

The result of this study revealed that the F1 generation performed far better in growth as well as it showed higher body parameters in compared to Vigova Super M Duck and Pati Duck. Linear body traits showed variation in performance of both sexes. The variations in linear body measurements of F1 generation ducks could also be attributed to gene expression at different stages of growth in each gender. This implied that body weight was highly dependent on growth of other component parts of the body. These ducks performed well under the agro-climatic condition of Assam. These ducks could be reared

**Table 6.** Color pattern of matured F1 generation ducks and drakes:

Sl. No.	Overall Colour pattern of F1 Generation Ducks and Drake	Head colour	Neck colour	Wing colour	Back colour	Tail colour	Thigh colour	Breast colour	Bill colour	Eye colour	Eyelid colour	Feet colour
1	White drake	White	White	White	White	White	White	White	Yellow	Brown	White	Yellow
2	White Duck	White	White	White	White	White	White	White	Yellow	Brown	White	Yellow
3	Whitish light brown drake	White	Brown	Brown	Brownish	Brownish	Brown	Brown	Yellow	Brown	Black	Yellow
4	Whitish light brown duck	Yellowish brown	White	Light Brown	Whitish Brown	Brown	Brown	Light Brown	Yellow	Brown	Brown	Yellow
5	Blackish brown drake	Greyish Black	Brown	Brown	Brown	Brownish	Brown	Brown	Yellow	Black	Black	Yellow
6	Blackish brown duck	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish	Yellow black	Brown	Brown	Yellow
7	Black & white drake	Greyish black	Greyish black with white spots	Greyish black	Greyish black	Greyish black	Greyish black	Brownish white	Yellow	Black	Black	Yellow
8	Black & white duck	White and black spot	Black & white	Brownish black	Greyish black	Brownish black	Greyish black	Light Brown	Yellow	Black	Brown	Yellow
9	Khaki coloured drake	Brownish black	Greyish black	Brown	Brown	Greyish black	Brown	Brown	Yellow	Brown	Brown	Yellow
10	Khaki coloured duck	Brownish Black	Brownish Black	Brownish Black	Brownish Black	Brownish Black	Brownish Black	Brownish Black	Brown	Brown	Black	Yellow

on large scale to increase duck production under freerangefarming conditions. The ducks fed on Broiler ration shows a higher body weight gain as compared to layer ration.

Conflict Of Interest: Authors declare that they have no Conflict of Interests for this article.

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### References

- Kadir Önk, Mehmet Sarý, Ismayil Safa Gürcan and Serpil Adýgüzel Iþýk, 2018. Live weight and body measurements of male and female native ducks raised in different raising systems. *Brazilian Journal of Animal Science* © 2018 Sociedade Brasileira de Zootecnia ISSN 1806-9290 www.sbz.org.br
- Solomon, J. K. Q., Austin, R., Cumberbatch, R. N. Gonsalves, J. and Seaforth, E. 2006. A comparison of live weight and carcass gain of Pekin, Kunshan and Muscovy ducks on a commercial ration. *Live-stock Research for Rural Development*. 18 (11).
- Perez, R. 1985. Duck - Rearing manual, University of the West Indies, St Augustine, Trinidad. www.lrrd19/7/solo19091.htm.
- Baeza, E., Williams, J., Guemene, D. and Duclos, M.J. 2001. Sexual dimorphism for growth in Muscovy ducks and changes in insulin-like growth factor I (IGF-I), growth hormone (GH) and triiodothyronine (T3) plasma levels. *Reprod. Nutri. Dev.* 41(2) : 173-9.
- Etuk, I. F, Ojewola, G.S. and Abasiokong, S.F. 2006. Performance of Muscovy Ducks under three management systems in South Eastern Nigeria. *International Journal of Poultry Science*. 5 (5): 474-476.
- Ogah, D.M., Alaga, A.A. and Momoh, M.O. 2009. Principal component factor analysis of the morphostructural traits of Muscovy duck. *Inter. Journal of Poult. Sci.* 8 (11) : 1100-1103.
- Yakubu, A. 2009. An assessment of sexual dimorphism in African Muscovy ducks (*Cairinamoshata*) using morphological measurements and discriminant analysis. *In Proc. of 4th World Water Fowl Conf.* Thrissur India, Pp. 59-63.
- Lorenzo, J.M., Purriños, L., Temperán, S., Bermúdez, R., Tallón, S. and Franco, D. 2011. Physico-chemical and nutritional composition of dry-cured duck breast. *Poult. Sci.* 90: 931-940.
- Tai, C. and Tai, J.J.L. 2001. Future prospects of duck production in Asia. *Journal Poult. Sci.* 38 : 99-112.
- Zanusso, J., Rémignon, H., Guy, G., Manse, H. and Babiléand, R. 2003. The effects of overfeeding on myofibre characteristics and metabolic traits of the breast muscle in Muscovy ducks (*Cairinamoschata*). *Reprod Nutr Dev.* 43 : 105-116.
- Saez, G., Davail, S., Gentès, G., Hocquette, J.F., Jourdan, T., Degrace, P. and Baéza, E. 2009. Gene expression and protein content in relation to intramuscular fat content in Muscovy and Pekin ducks. *Poult Sci.* 88 : 2382-2391.
- Fournier, E., Peresson, R., Guy, G. and Hermier, D. 1997. Relationships between storage and secretion of hepatic lipids in two breeds of geese with different susceptibility to liver steatosis. *Poult Sci.* 76 : 599-607.
- Davail, S., Guy, G., Andre, J.M., Hermier, D. and Hoo-Paris, R. 2000. Metabolism in two breeds of geese with moderate or large overfeeding induced liver steatosis. *Comp Biochem Physiol A: Mol Integr Physiol.* 126 : 91-99.
- Su, S.Y., Dodson, M.V., Li, X.B., Li, Q.F., Wang, H.W. and Xie, Z. 2009. The effects of dietary betaine supplementation on fatty liver performance, serum parameters, histological changes, methylation status and the mRNA expression level of Spot 14á in Landes goose fatty liver. *Comp Biochem Physiol A: Mol Integr Physiol.* 154: 308-314.
- Ajit, B.B., Padwal, N.P., Anish, D., Deepa, G.M. and Peethambaran, P.A. 2009. Evaluation of bill length and shank length in kuttanad ducks of kerala. *Proceedings of the IV World Waterfowl Conference, Trisur, India 2009*, 173p.
- Murugan, M., Gopinathan, A. and Sivakumar, T. 2009. Indigenous duck varieties in Uthiramerur block of north eastern agroclimatic zone of Tamil Nadu. *Proceedings of the IV World Waterfowl Conference.* 89-92p.
- Phookan, A., Das, B., Das, A., Islam, R., Sharma, M. and Bharali, K. 2018. Morphology, morphometry and certain egg quality traits of indigenous ducks of North Eastern region of India. *International Journal of Chemical Studies.* 6(2) : 3131-3133.
- Zaman, G., Goswami, R.N., Aziz, A., Nahardeka, N. and Mahanta, J.D. 2007. Studies on body weight and shank length of Nageswari duck of Assam. *Indian Journal of Poultry Science.* 42(1) : 79-80.