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Research Article

Effect of Replacing Soybean with Pigeon Pea on Growth Performance and Meat Quality

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Abstract

A study to assess the effect of replacing Soybean with Pigeon pea on growth performance, meat quality and sensory characteristics of Malawian Indigenous Muscovy ducks was conducted at Bunda Campus of the Lilongwe University of Agriculture and Natural Resources (LUANAR). The study used forty-two (42) ducks which were assigned to two treatments (T1:21 ducks on Soybean meal based-ration, T2:21 ducks on Pigeon pea-based ration). Major feed ingredients were analyzed for nutrient composition before formulating ration. Starter of 20% CP and finisher of 17% CP was fed to ducks in an intensive system. Weekly body weights were measured and used to determine average daily body weight gain which showed better results on pigeon pea fed ducks. Feed conversion ratio were statistically significant with pigeon showing the best value of 2.0 ± 0.00 and Soybean 2.24 ± 0.00. At the 12th week of age, six ducks from each treatment were selected with reference to mean weight and then slaughtered. Using the right breast muscle, Carcass temperature, and pH were measured at 45minutes, 3hours, 6hours, 12 hours and 24hours post-mortem. Cooking loss, drip loss, and color were determined at 24hours post-mortem. There was no difference between treatments on redness (a*) but the difference was observed on lightness (L*) and yellowness (b*). The left breast muscle was cut from each duck, labelled then chilled at 4 ^{0}C for 24hours followed by cooking at 70 ^{0}C for 15 minutes by boiling. Trained panelists scored the meat samples for sensory characteristics. The results showed that the panelists preferred duck meat from pigeon pea-based ration to Soybean based ration. Therefore, pigeon pea can replace soybean as a protein source since it has a positive effect on Malawian Indigenous Muscovy ducks.

Keywords: Breast Muscle; Carcass Feedstuff; Feed Conversion Ratio; Proximate Analysis

Introduction

Duck production is one of the poultry enterprises practiced in Malawi. Ducks are kept for meat, eggs and feathers. The production of duck meat has risen steadily in recent years and has become the third most widely produced poultry meat in the world after chicken and turkey [1]. The increase in duck production is due to the fact that ducks are easier to keep as compared to other poultry species because they are resistant to most diseases like Newcastle and adapt to different environments [2]. Ducks are also known to have higher live weight, for example, a male duck can grow up to 4.8 kg in 12 weeks. Duck can also be used to control pests in areas where flies are a problem. After 4 weeks ducks can search for their own feed but for better conversion a balanced ration is required [3]. On the same note, the duck price is affordable as compared to other poultry species.

Duck meat has relatively high fat content like any other red meat and levels of intramuscular phospholipids, which play a crucial role in the development of meat flavour. The nutritional composition of duck meat varies depending on the breed. For example, Pekin duck contains more fat as compared to the Muscovy duck, so people tend to like Muscovy more than Pekin as people are more concerned with what get into their body these days so they tend to eat food with less fat content. Meat quality characteristics in poultry may be influenced by many factors such as animal species and breeds, environment, feeding, and care conditions [4].

Pigeon pea has ability to resist drought and cheap to produce. Pigeon pea is a protein-rich edible pea that is consumed both fresh and dry. Pigeon peas provide a good supplement to a staple-based meal. They complement a staple-based meal [5].

They complement the protein profile, supply iron and are a strong source of micronutrients, including vitamin A, C, and B, and Calcium making it a very valuable for improving food security and nutrition for many families who cannot afford dairy and meat-based diets. Pigeon pea production in Malawi is dominated by smallholder farmers with limited access to market information and who are also faced with lack of access to improved varieties. The local pigeon pea market is highly fragmented and disorganized.

Materials and Methods

Location

The experiment was conducted at the Lilongwe University of Agriculture and Natural Resources (Latitude: -14.1808182047 and Longitude: 33.7773920253), Animal Science Student Farm (Poultry Section) using Malawian Indigenous Muscovy ducks. Meat quality assessment and analysis of feed samples was conducted at Animal Science Research Laboratory (ANS RL). Meat evaluation for its tenderness, colour, aroma and juiciness content was conducted at Food Science Laboratory (FSL).

Experimental animals

Ducklings were hatched naturally and fed starter (22%CP) for the first four weeks of age and finisher (17% CP) from week five to point of slaughter (12 weeks). The ducklings were raised under intensive management system. They were assigned to two treatments (T1 (n = 21): soybean-based ration and T2 (n = 21): Pigeon pea-based ration). where n = number of birds per treatment. Each treatment had three replicates of seven ducklings each in a completely randomised design. The ration was formulated using the Pearson Square method and the feed was prepared at Animal Science Department Student Farm. Both Soybeans and pigeon peas were sundried, heat-treated (roasting) then milled. The milled sample then undergo proximate analysis for crude protein, dry matter, and crude fibre at Animal Science Research Laboratory.

At the start of the experiment Muscovy ducklings were vaccinated against *Gumboro* and Newcastle disease and were dewormed with Piperazine. Although ducks are resistant to most avian diseases and do not have standard vaccination programme, they are regarded as carriers of some poultry diseases [6]. Later they were individually weighed and tagged for identification. Feed and water were provided *ad-libtum*, each treatment had twenty-one mixed sexes with three replicates of seven ducks each. The first two weeks were for acclimatisation to feed then data were collected on third week. Data collected included weekly body weights, linear body measurements (body length, wingspan, keel length, girth circumference), Feed conversion ratio, daily feed offered and feed refusal were recorded to calculate feed intake.

Meat samples and preparation

At the end of the experiment, six ducks whose final weights were close to the mean weight of the group were selected from each treatment for slaughter. Feed was withdrawn 12 hours before slaughter, and only water was given within this period. The selected ducks were slaughtered using a sharp knife by throat slitting. They were then dressed and right breast part of each processed duck was placed in a plastic transparent bag and labelled, the samples were then kept in the chiller at 4 °C for 24 hours for further analysis such as cooking loss, drip loss and meat colour. Duck breasts (*Pectoralis* muscle) were analysed for meat quality attributes since the breast is crucial part for the culinary value and technological properties of duck meat. The left breast muscle from each processed duck was cut into small pieces (1.5cm thick, approximately 100g). The meat samples from each processed duck were packed in small transparent plastic bags, labelled, tied and then chilled for 24 hours at 4^0 C. After 24 hours the chilled meat samples from both soybean and pigeon pea fed ducks were taken out of refrigerator and then cooked separately in the Food Science laboratory by boiling at 70^o C for 15 minutes (turned every 3 minutes).

Taste panel evaluation

Taste panels were tested and recruited to score the meat on sensory characteristics. The panellists were chosen in reference to the screened questionnaire whereby a total of 12 panellists (six males and six females), of age ranging between 18-26 years were involved.

Experimental design

Carcass pH and temperature profiles were measured by a pH meter and thermometer respectively [7] at 45 minutes, 3 hours, 6 hours, 12 hours, and 24 hours post mortem and recorded. The pH meter and thermometer dipped into the breast to at least a depth of 2 cm at a similar place.

Meat colour was determined by means of a Konica Minolta CR400 Chroma meter, whereby 30 x 30 mm samples from the breast was prepared, labelled and used to capture colour scores of lightness (L*), redness (*a**), and yellowness (b*).

Drip loss was determined by cutting and weighing 20g of breast muscle. Meat samples were put in a chiller (4 °C) for 24 hours. After that, they were surface dried and weighed. The actual drip loss in percentage was calculated using the below formula:

Drip loss (%) = [(A-B)/(A)] × 100 [6].

Cooking loss was determined by cutting and weighing 20 g of the breast muscles. The meat samples were put in the plastic papers and boiled in a water bath to an internal temperature of 90 °C for 30 minutes. After boiling, the samples were surface dried, and weighed.

Cooking loss was determined by expressing weight of cooked sample (B) as a percentage of the precooked sample (A)

Cooking loss (%) = [(A-B)/(A)] × 100 [8].

The meat samples were scored for sensory characteristics using a 9-point Hedonic rating scale method. In this method consumers rank samples for their sensory attributes by ticking in any of the boxes provided ranging from 1 = 'extremely dislike' to 9 = 'extremely like'.

Using these levels, the meat samples were evaluated on the colour, aroma, tenderness and juiciness. Samples were evaluated in two sessions for one day.

Six samples were evaluated by each panellist per session. The samples were labelled as A or B and the panellists were instructed to cleanse their mouth between samples using warm water. The cleansing was done to avoid mixing the taste of previously tasted sample with the one about to be tasted by restoring the normal fluid environment in the mouth.

Statistical analyses

Data were analysed using descriptive statistics of SPSS (version 22; Chicago, IL, USA). Paired T-test was used to compare means of two treatments i.e., soybean-based meal and pigeon pea-based meal. Each duck was regarded as an experimental unit and the statistical significance was set at P < 0.05. Means and standard errors of mean (SEM) are reported.

Results and Discussion

Effects of protein sources on weight, average daily gain, feed conversion ratio and linear body measurements

Results on the effect of protein source on initial weight, final weight, feed intake, average daily gain and feed conversion ratio have been presented in table 1. The study found out that there was a difference in initial weight, final weight gain, average daily gain, and feed conversion ratio between ducks fed soybean meal and pigeon pea meal rations.

Variables	Soybean	Pigeon pea	P-value
Initial weight (g)	400.3 ± 0.38	401.2 ± 0.19	0.10
Final weight(g)	3201.5^a ± 0.27	3420.0^b ± 0.25	0.00
Feed intake(g)	112.8^a ± 0.03	111.9^b ± 0.01	0.00
Average daily gain(g)	19.1 ± 0.53	17.4 ± 0.83	0.42
FCR(g)	3.6^a ± 0.03	$3.5.00^b$ ± 0.01	0.00

Table 1: Means (± SE) of final weight and initial weight, feed intake, ADG and FCR.

^{ab}: Means different superscripts within rows are significantly different (P value < 0.05)

Means of body weight of ducks fed pigeon pea increased significantly from week 3 to week 12 of the trail period and the values shown highest body weight of pigeon compared with the soybean. Ducks fed soybean shown relatively lowest body weight among treatments. This study also found out that there is no significant difference in average daily gain similar to [8] findings of average daily gain but rather significance in feed conversion ratio although in my findings it is poorer FCR (3.49/bird) compared to [9]. It was found out that pigeon pea is better as a protein source as feed conversion ratio is a measure of how efficiently the body of an animal converts animal feed into the desired output and in this case of this study weight of pigeon pea is slightly higher than soybean because it needed less feed to produce 1000g (1kg) of body. Feed intake were significant among the treatment a little bit similar of [8] who found that feed intake of Muscovy duck with similar age is ranged between 128.54 - 131.14 g/bird/day.

Results on the effect of protein sources on linear body measurements (wingspan, heart girth, keel length and body length) are presented in table 2. The study found out that there is a significant difference between ducks fed soybean meal and pigeon pea meal.

Variable	Soybean	Pigeon pea	P value
Wing length	$40.5^a \pm 0.92$	$36.9^b \pm 0.15$.	0.00
Chest circumference	$24.6^a \pm 0.41$	$23.6^b \pm 0.06$	0.01
Keel length	$23.1^a \pm 0.13$	$24.9^b \pm 0.06$	0.00
Body length	$45.6^a \pm 0.16$	$44.9^b \pm 0.24$	0.05

Table 2: Mean (± SE) of protein sources on linear body measurements.

Means different superscripts within rows are significantly difference (P value < 0.05).

Results on effect of average daily gain of Muscovy ducks fed Soybean and Pigeon pea are presented in figure 1. It was found that ADG at 6 and 11 weeks were different between the two treatments. ADG for ducks fed soybean-based ration at 6th and 11th week were 20.7 ± 1.2 and 21.3 ± 1.7 respectively and pigeon pea were 16.7 ± 1.5 and 15.9 ± 1.4 respectively. This results at week 6 and 11 are in similar range of [8] findings. In this study found out that as age and live weight increased linear body measurements also increased in all the treatments similar to [9] who reported that live weight and body measurements increased with increasing age. Growth is characterized by increase of body weight, development is characterized by changes in functions, structure, and shape of tissues and organs in the body [9]. Protein source had no effect on linear body measurements. This study also found that there is a positive correlation between weight and linear body measurements. Wingspan, body length and girth circumference were statistically different with soybean having the best value and only girth circumference had a best value for pigeon pea.

Figure 1: Average daily gain (g) of Muscovy duck fed soybean and pigeon pea.

Period soybean pigeon

Results on table 3 shows Pearson correlation on initial weight and linear body measurements.

The study found out that there is a positive correlation between girth circumference and initial weight.

	Initial weight	Wing length	Chest circumference	Keel length	Body length
Initial weight	1				
Wingspan	-0.364^*	1			
Chest circumference	- 0.291	0.838^{**}	1		
Keel length	0.204	- 0.289	- 0.125	1	
Body length	- 0.101	0.333^*	0.258	- 0.281	1

Table 3: Pearson correlation between initial weight and linear body measurement.

The result showed that the correlation coefficient between initial weight and body dimensions of the Muscovy ducks were 0.84, 0.33 for chest circumference and body length respectively slightly less to what [10] found. The positive direct effect of chest circumference was higher and negative direct effects on initial weight and body dimensions of wing length and keel length were -0.36, -0.825 respectively.

Results on table 4 shows Pearson correlation on final weight and linear body measurements. The study found out that keel length and girth circumference is a positively highly correlated to final weight.

	Wing length	Chest Keel length circumference		Body length	Final weight
Wing Length	1				
Chest circumference	0.838**	1			
Keel length	- 0.289	- 0.125	1		
Body length	0.333*	0.258	- 0.281	1	
Final weight	- 0.558**	- 0.396*	0.905**	-0.340*	1

Table 4: Pearson correlation between final weight and LBM.

Effects of protein sources on meat quality

There was significant difference ($P < 0.05$) in the duck meat at 45minute post-mortem in carcass pH and temperature. After 24 hours post-mortem there was no significant difference ($P < 0.05$) in both pH and temperature as shown in table 5. For pH trend, at 45 minutes post-mortem treatment 1 (Soybean based Meal) had higher pH than treatment 2 (Pigeon Pea based Meal), pH in soybean-based meal ducks drops faster than pigeon pea-based meal ducks up to 24 hours post-mortem where there was no difference (T1 = 5.15, T2 = 5.17) as shown in figure 3

For temperature, pigeon pea fed ducks had higher temperature values than soybean fed ducks at 45 minute and it drop faster up to a point where temperature in pigeon pea fed ducks was lower than soybean fed duck (Figure 2) up to 24 hours post-mortem where there was very slight difference (T1 = 5.91 ^{0}C, T2 = 6.31 ^{0}C in table 5) as shown in table 5.

Figure 2: Carcass temperature from 45 minutes to 24 hours.

Figure 3: Carcass pH from 45 minutes to 24 hours post slaughter.

pH and Temperature	Feed		
	Soybean based meal	Pigeon pea-based meal	P-value
Initial pH (45 min)	7.667 ± 0.177	6.897 ± 0.135	0.00
Ultimate pH (24 hours)	5.238 ± 0.050	5.158 ± 0.063	0.21
Initial temperature (45 min)	28.333 ± 0.477	34.917 ± 0.271	0.00
Ultimate temperature (24 hours)	5.916667 ± 0.095	6.33 ± 0.260	0.96

Table 5: Means (± SE) for carcass temperature and pH.

Muscle pH is very important when it comes to preservation of meat for it determines the microbial growth in meat. Low muscle pH result in long shelf life. The decrease in pH determines the colour and even drips loss of meat [11].

This is different with current results in both treatments. This can be due to feed stuffs added to the feed. The current results, pH was lower than those mean values. This indicates good meat quality [12].

All treatments present lower pH values of between 5.24 and 5.16 for soybean and pigeon pea fed ducks [13], indicated that pH of meat is affected by fasting period and exposure to high temperature before slaughtering. The ducks of which current results were obtained were slaughtered early in the morning when the temperatures were around 22 °C which may cause lowering of meat pH [15]. Lowering of pH can also be due to stress, these ducks experienced during slaughtering because they were slaughtered using local method of straight neck cut. Ducks in [16] were slaughtered using commercial facilities and stunning (electric) was involved which helps in reducing stress due to pain during slaughter. There was significant difference for colour score of Lightness (L*) and yellowness (b*) but no significant difference in Redness (a*) between treatments as shown in table 6 at 24 hours post-mortem. Lightness (L*) values for soybean meat was higher than that of pigeon pea.

Colour Score	Feed		
	Soybean Based Meal	Pigeon Pea Based Meal	P- Value
Lightness (L*)	55.643 ± 1.619	49.655 ± 2.134	0.01
Redness (a*)	13.933 ± 1.898	16.042 ± 1.177	0.18
Yellowness (b*)	5.56 ± 0.487	7.505 ± 0.223	0.00

Table 6: Means (± SE) for the colour of duck meat.

Meat colour affects consumer's preference and purchasing decision. Temperature and pH decline, cooking method, age, sex and also rearing system affect the meat colour [17]. The current results are closely similar to what was reported by [15] who found a* = 15.86 and b* = 12.18 and according to [4], they found that a* = 12.4, b* = 12.8. Since duck meat is reddish which is composed of more red muscle than white muscle, the redness score will be the most colour score to focus on. Because of no significant different ($P < 0.05$) between the two treatments, on colour part, pigeon pea has no effect on duck meat colour and its colour mean a* and b* was higher in pigeon pea fed ducks than in soybean fed ducks and only lightness was higher in soybean fed duck meat than in pigeon pea fed duck meat. The results which [16] found indicates lower values of L* and b* than the current results. The difference may be due to different slaughter method. Ducks in [16] were first stunned which reduce stress during slaughtering but no stunning was done to these ducks where current results were obtained. The other difference can also be due to age in which those in [16] were slaughtered at 45 days and current ones at 84 days old.

The protein source (soybean and pigeon pea) on cooking loss and drip loss are presented in table 7. The results show that both drip loss and cooking loss were not affected by protein source for there was no significant difference ($P < 0.05$).

Parameter	Feed		
	Soybean Based Meal	Pigeon Pea Based Meal	P-value
Cooking loss	33.579 ± 2.346	30.871 ± 1.105	0.22
Drip loss	3.193 ± 0.799	3.308 ± 0.840	0.47

Table 7: Means (± SE) for the drip and cooking loss.

Cooking brings loss of soluble protein, vitamins and is a factor of period of cooking and temperature [18] for which in these current results were kept constant. The current results of cooking loss were similar with those reported by [4] who found that for female = 31.7% and those of [16] under intensive system.

The results in terms of cooking loss were significantly the same ($P < 0.05$) despite having different slaughter method and different age as opposed to other studies which states that cooking loss differ due to feeding, age and method of slaughter. In terms of drip loss, the results are in range with what [18] found. This can be due to similar chilling temperature (4 °C) and time period of chilling (24 hours).

Effect of protein sources on sensory characteristics

Table 8 shows the effect of protein sources on meat colour, aroma, juiciness and tenderness of Malawian indigenous Muscovy duck meat. This study shows a slight increase in parameter in ducks fed pigeon pea unlike soybean meal. The panellists preferred meat from pigeon pea-based ration in terms of aroma and colour. And it was also discovered that meat from pigeon pea was more tender and juicier unlike the one from Soybean based ration ($P \le 0.05$) for all the meat attributes between the different protein sources.

Parameters	Protein source		
	Soybean	Pigeon pea	P value
Aroma	7.9 ± 0.18^a	8.6 ± 0.11^b	0.01
Colour	7.2 ± 0.19^a	8.4 ± 0.11^b	0.00
Juiciness	6.9 ± 0.28^a	8.0 ± 0.17^b	0.01
Tenderness	7.7 ± 0.15^a	8.1 ± 0.05^b	0.03
Overall acceptability	7.4 ± 0.17^a	8.3 ± 0.09^b	0.00

Table 8: Effect of protein sources on meat aroma, colour, juiciness and tenderness.

^{ab}: Means with different superscripts within the rows are significantly different ($P \le 0.05$).

Aroma

The present results on effect of plant protein source on duck meat aroma shows a significance difference ($P \leq 0.05$) between the treatments. These results agree with a previous study by [19] which indicated that aroma is affected by animal feeding due to phospholipid compounds found in some feeds like Pigeon pea which influence the meat aroma because the former have a greater proportions of polyunsaturated long-chain fatty acids, and therefore, are more susceptible to lipid oxidation which creates pleasant aromas in cooked meat. The phospholipids are particularly susceptible to chemical changes which may occur as a result of high temperatures during boiling or frying.

Colour

According to the results shown in table 1, there is a significant difference ($P \leq 0.05$) in-terms of the likeliness of the colour from the two protein sources. Most panellists liked the meat colour of Pigeon pea unlike Soybean. The difference may be due to difference in Muscle pH of duck meat from two different protein sources as it corresponds to the results found by [20] which states that muscle pH can influence the development of meat colour.

Juiciness

The highest juiciness rating was given by the panellist to the meat from pigeon pea meal-based diet. The lowest value was given by the panellist to the meat from soybean meal-based diet. These results shows that there is a significant difference ($P \leq 0.05$) between the ducks from different protein sources as far as juiciness is concerned. However, several reports partially agrees with these results as they have shown that the inclusion of pigeon peas in poultry diets, especially broilers have detrimental effect on the performance of broilers and laying hens [20]. Other study reported that dietary pea inclusion improves performance and meat quality of broiler chickens [21].

Tenderness

The results from table 1 above shows that sensory panellists put much scores on meat from Pigeon pea-based meal unlike Soybean based meal. This simply indicates that meat from Pigeon pea-based meal was tenderer as compared to the one from Soybean based meal. The results could be due to protein intake, IMF content, collagen and calcium levels provided by Pigeon pea which were not there in Soybean. These results are in agreement with [23] who reported that IMF content was strongly related to tenderness evaluated by sensory panel in Japanese Black Steer, as the consumers in Japan preferred a well-marbled beef. On the other hand, the contractile characteristics of muscle are associated with sensory quality; especially meat tenderness [22].

Correlation among sensory parameters; aroma, colour, juiciness and tenderness

Table 9 shows the correlation among the tested parameters, aroma, colour, juiciness and tenderness. The results are showing positive correlation among all the parameters but the degree of correlation between each parameter is different.

For example, juiciness and colour are strongly correlated with a proportion of 96%, and the least correlated parameters are colour and aroma, these are showing the proportion of 79%.

	Aroma	Colour	Juiciness	Tenderness
Aroma	1			
Colour	0.787**			
Juiciness	0.853**	0.958**		
Tenderness	0.855**	0.869**	0.907**	1

Table 9: Correlation among sensory parameters; Aroma, Colour, Juiciness and Tenderness.

**. Correlation is significant at the 0.01 level (2-tailed).

Correlation between aroma and colour

Colour and Aroma are used more or less interchangeably when it comes to consumer's choice of food. From this experiment aroma and colour has a positive correlation with a degree of 79%. This is because colour cues appear to have some effect on aroma. Most consumers do believe that food with nice colour (mostly brownish in meat) is likely to smell nicely as well and hence influencing the taste and the overall acceptability. Certainly, getting the colour right can play an important role in food acceptance, liking, and hence, ultimately food intake.

Correlation between aroma and juiciness

The panellists found aroma and juiciness to have a positive interaction. The degree of interaction being 85%. Not all panellists liked both aroma and juiciness and this caused the degree of interaction to be less than 100%. A study by [23] on correlations of sensory quality characteristics with intramuscular fat content and bundle characteristics in bovine Longissimus thoracic muscle also found that the degree of interaction is as a result of personal likes/dislikes and eating experiences.

Correlation between aroma and tenderness

The aroma and tenderness of cooked indigenous duck meat was found to have a positive correlation, with about 86% degree of correlation. These results could be due to the high water composition in meat since 75% of it is water and other nutrients like proteins its only 18% of it in meat. The water is what makes any food tender [24].

Correlation between colour and juiciness

The relationship between food colour and juiciness is presumed to be a learned association shaped by everyday experience with foods. Sometimes the success in eliciting this association depends on the part of experimental design. According to this experiment where a 9-point hedonic scale was used, the panellists found that colour and juiciness are positively correlated with 96% degree of correlation. One contributing factor to this correlation could be the subject's ability to discriminate the various concentration of chemosensory stimuli used in the test food [25].

Correlation between colour and tenderness

On colour and tenderness, the panellists found that there is a positive interaction between these two parameters. The degree of correlation was found to be 87%. Using the results found on the interaction between colour and tenderness, it can be concluded that cooked meat colour can determine the level of toughness or tenderness in a particular meat. Therefore, increasing the colour quality in food can lead to enhanced consumption [26]. What we see can also lead to a suppression of our appetitive behaviours when associated with off-colour [27].

Correlation between tenderness and juiciness

The current study shows that tenderness and juiciness are positively correlated with 91% which is second to the strongly correlated parameters (colour and juiciness). Tenderness and Juiciness are palatability parameters that are considered as the most important characteristics that determines consumer satisfaction.

Sensory quality traits of cooked meat, specifically tenderness, juiciness and overall acceptability, are influenced by intramuscular fat (IMF) content. Breast meat muscle contains greater amount of IMF hence tenderer and juicier compared to other muscles, for instance, thigh [28].

Conclusion

This study found out that protein source has an effect on linear body measurements, weight gains and feed conversion ratio. It can also be concluded that pigeon pea can replace Soybean for meat quality in terms of colour, drip loss and cooking loss without having a negative effect on meat quality. This has been shown by no significances in cooking and drip loss which prevent losses that comes when preparing and storing meat respectively, redness in colour which improves appearance and ultimate pH and temperature which determine the shelf life and flavour. As observed by panellists who preferred duck meat fed pigeon pea also from the observation that some parameters are positively correlated like colour vs. aroma and juiciness vs. tenderness, it can also be concluded that protein source has an effect on the sensory characteristics of Malawian Indigenous Muscovy duck meat.

However, another study can be conducted on protein inclusion levels of pigeon pea and the effects of pigeon pea on cost benefit analysis as this was just 100% inclusion.

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Bibliography

1. FAO. Livestock-related interventions during emergencies - The how-to-do-it manual, Manual No. Rome (2016).
2. EZ Sambala and L Manderson. "Anticipation and response : pandemic influenza in Malawi, 2009". *Global Health Action* 10.1 (2017).

3. LI Hui-fang., *et al.* "Myofiber development during embryonic to neonatal development in duck breeds differing in muscle growth rates". *Journal of Integrative Agriculture* 15.2 (2016): 403-413.
4. G. Kaneko. "Impact of pre-mortem factors on meat quality: An update". *Foods* 10.11 (2021): 16-18.
5. KB Waldman., *et al*. "Estimating demand for perennial pigeon pea in Malawi using choice experiments". *Ecological Economics* 131 (217): 222-230.
6. J Tanganyika and EC Webb. "Influence of production systems and sex on nutritional value and meat quality of native Malawian Muscovy ducks". *South African Journal of Animal Science.* 49.6 (2019): 1113-1126.
7. H Kim., *et al*. "The Study on Growth Performance and Carcass Yield of Meat-type Korean Native Ducks". *Korean Journal of Poultry Science* 39.1 (2012): 45-52.
8. MI Khan., *et al*. "Marination and Physicochemical Characteristics of Vacuum-aged Duck Breast Meat". *Asian-Australasian Journal of Animal Sciences* 29.11 (2016): 1639-1645.
9. HO Abah., *et al*. "Waste Management Practices in Selected Poultry Farms and its Effect on the Environment and Human Health in Makurdi, Nigeria". *International Journal of Agriculture Environment and Biotechnology* 4.1 (2019): 121-127.
10. R Sebro. "Statistical estimation of deltoid subcutaneous fat pad thickness: implications for needle length for vaccination". *Scientific Report* 12.1 (2022): 1-8.
11. M Gagaoua., *et al.* "Proteomic biomarkers of beef colour". *Trends in Food Science and Technology* 101 (2020): 234-252.
12. C Álvarez., *et al*. "Effect of Pre-Slaughter Practises and Early Post-Mortem Interventions on Sheep Meat Tenderness and Its Impact on Microbial Status". *Foods* 11.2 (2022).
13. A Tassoni., *et al*. "State-of-the-Art Production Chains for Peas, Beans and Chickpeas - Valorization of Agro-Industrial Residues and Applications of Derived Extracts". *Molecules* 25.1383 (2020): 1-21.
14. E Baéza. "La viande de canard : production et principales caractéristiques canard : production et principales caractéristiques". *Institut National De La Recherche Agronomique* 8.2 (1995): 117-125.
15. K Kyriakopoulou., *et al*. "Functionality of ingredients and additives in plant-based meat analogues". *Foods* 10.3 (2021).
16. AM Johnson., *et al*. "Effect of chitosan edible coating with plant extracts on shelf life of chicken during refrigeration condition". *The Pharma Innovation Journal* 10.10 (2021): 850-854.
17. G National and H Pillars. "No Covariance structure analysis of health-related indicators in the elderly at home with a focus on subjective health".
18. YSI Adam and HA Abugroun. "Evaluation of Traditional Cooking Methods on Eating Meat Characteristics and Chemical composition". *IOSR Journal of Agriculture and Veterinary Science* 8.4 (2015): 12-17.
19. E H Ulfa. "Scattered". *SALE - Junaid Jamshed*5.1 (2020): 55.
20. D Diaz., *et al.* "Pea seeds (Pisum sativum), faba beans (Vicia faba var . minor) and lupin seeds (Lupinus albus var . multitalia) as protein sources in broiler diets : effect of extrusion on growth performance faba beans (Vicia faba var . minor) in broiler diets". *Italian Journal of Animal Science* 5.1 (2006): 43-53.
21. V Laudadio and V Tufarelli. "Growth performance and carcass and meat quality of broiler chickens fed diets containing micronized-dehulled peas (Pisum sativum cv . Spirale) as a substitute of soybean meal". *Poultry Science* 89 (2010): 1537-1543.
22. YM Choi., *et al.* "Correlations of Sensory Quality Characteristics with Intramuscular Fat Content and Bundle Characteristics in Bovine Longissimus Thoracis Muscle Correlations of Sensory Quality Characteristics with Intramuscular Fat Content and Bundle Characteristics in Bo" 32.9 (2019): 197-208.
23. C Gajaweera., *et al.* "Evaluation of sensory attributes of hanwoo longissimus dorsi muscle and its relationships with intramuscular fat, shear force, and environmental factors". *Canadian Journal of Animal Science*98.3 (2018): 443-452.
24. ADAAB Dalil. "Effect of Partial Replacement of Meat by Pigeon pea (Cajanus cajan L.) on the Nutritional and Sensory Characteristics of Burger". *Sudan University of Science and Technology* (2017).
25. C Spence. "A Review On the psychological impact of food colour". *Spence Flavour* 4.21 (2015): 1-16.
26. B Piqueras-fiszman and C Spence. "Colour , pleasantness , and consumption behaviour within a meal". *Appetite* 75 (2014): 165-172.
27. J Liu., *et al.* "Chinese consumers' attitudes and potential acceptance toward artificial meat". *Foods* (2012): 10.2.

28. Y Lee., *et al.* "Sensory quality characteristics with different beef quality grades and surface texture features assessed by dented area and firmness, and the relation to muscle fiber and bundle characteristics". *Meat Science* 145 (2018): 195-201.