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# Effect of Free-Range Strategy on Taste of Conventional Broiler Meat in Coastal Lowlands of Kenya

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**Abstract** | Studies have shown that meat from indigenous chicken is more preferred than that of convectional broilers because of it is chewy low fat content attributed to the low n-6/n-3 fatty acids ratio compared to broiler meat. Broiler meat products may attain this low fat content by allowing the birds access to outside ground to scavenge. This study aimed to bridge this gap by producing broiler meat that simulates that of the indigenous chicken in terms of taste. In a completely randomized block design experiment, 240 day-old chicks were randomly assigned to four free-range strategies (FRR) or treatments. In FRR A, FRR B and FRR C, day-old chicks were allowed free-range access at 2, 3 and 4 weeks of age, respectively. In FRR D (the control), day-old chicks were fed the commercial broiler starter and finisher diet for the entire experimental period of 8 weeks without outside access. Clean drinking water was offered *ad libitum*.The live weight of the chicken was recorded weekly and at 6, 7and 8 weeks of age three birds from each treatment slaughtered for sensory evaluation. The FRR had a significant impact on the aroma, flavour and overall acceptability of the meat (P<0.0001) with the chickens allowed free-range access at 2 weeks of age being the most preferred and the control without free-range access the least preferred. These results suggest that the longer broilers are exposed to outside access the tastier is their meat.

**Keywords** | Flavour, Conventional broiler, Free-range access, Cooking.

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## INTRODUCTION

Generally, consumers prefer to have high quality, convenient and safe meat products that contain natural flavour and taste (Aymerich et al., 2008). However, these preferences tend to change with increasing urbanization and growing household incomes (Nyoro and Ngugi, 2007). One such trend is preference for lean white meat over red meat (Moschini and Meilke, 1989). Although fish and poultry meat are the most preferred, captured fishery resources are dwindling and farmed aquaculture is still at an introductory stage for mass exploitation in Kenya. This has made poultry meat the main source of white meat. However, exotic poultry meat is not entirely lean and thus indigenous chicken has become the alternative (Nyaga, 2007). Furthermore, consumers are becoming increasingly interested in naturally produced and/or environment friendly products that they perceive to have high nutritional value, have fewer contaminants and have better flavour. Flavour has been defined as the stimuli given by the sample to the taster's receptors both oral and nasal when the sample is consumed orally (Pippin et al., 1954) is one of the most important factors affecting consumers' meat-buying habits and preferences (Sitz et al., 2005).

In the indigenous chicken free-range system, birds are kept with minimal care with no supplementation and the main feed resources for the birds includes grass, insects, earthworms and various seeds (Mwamachi et al., 2000; Birech, 2002). Consequently, birds take longer to reach market weight at 16 weeks or more (Chen et al., 2007; Tsai et al., 2006). Consumer preference for indigenous chicken products is associated with consumers' perception that the free-range system provides better welfare and health for the

chicken compare to the commercial systems (Owens et al., 2006). The main consideration affecting the purchase decision by consumers of indigenous chicken products is taste, which is considered different from those of broilers with price as a secondary consideration (Zanussi et al., 2003). Since the conventional broiler production system is well developed, manipulation of chickens under this system to attain improved taste was the aim of this study. The specific objective of the experiment was to determine whether different free-range strategies (FRR; i.e. when chicks were allowed free-range access) would affect the taste of the meat in terms of aroma, flavour and overall acceptability of chicken slaughtered at 6, 7 and 8 weeks of age.

## MATERIALS AND METHODS

### Study Site

The study was conducted at Pwani University in Kilifi County, which is 62 km to the north of Mombasa town in Coastal Kenya. The study site is located on 2° S latitude and 40°E longitude at an attitude of 16 m above sea level. The annual rainfall at the study site ranges from 900 - 1100 mm and the mean annual temperature from 25 - 30° C. The region has a marked dry season from January to March and a wet one from April to June. For the rest of the year there are variations in amount and distribution of the rainfall.

### Housing and Experimental Chicken

A poultry unit, that had a corrugated iron sheet roof, was divided into sixteen pens (2×1.5×1.2 m.) constructed from wood posts and plywood and chicken wire netting on the sides. Each pen was connected to a 4×2 m outdoor area fenced off using chain-link fence to restrict the birds. The indoor and outdoor areas were separated by the poultry unit wall with a small door in each pen to allow the chickens free access the outdoor area. Round waterers and hanging feeders were availed indoors and all the birds were sheltered indoors at night. All the experimental pens were enclosed in a bio-security compound.

240-day-old Arbo acre broiler chicks were purchased from *Kenchic* Poultry Company Kenya. All the chicks were placed in one large pen during the brooding phase and infrared lamps were used as a heat source. Clean drinking water and commercial broiler starter feed in mashed form were offered *ad libitum*in waterers and chick feed troughs. The use of chicken in this study was approved by Pwani University Ethics Review Committee in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

### Experimental Layout and Feeding of the Chicken

In a completely randomized block design experiment, 240 day-old chicks (16 groups of 15 chicks per pen) were randomly assigned to four treatments or free-range strategies (FRR). In FRR A, FRR B and FRR C, day-old chicks were allowed outside/free-range access at 2, 3 and 4 weeks of age, respectively without further supplementation of the starter or finisher diet for the rest of the experimental period. The free-range/outside access entailed weaning the chicks from the conventional broiler diet and allowing them to forage outside their pens. Each pen was supplemented with approximately 100 g of kitchen waste to mimic how indigenous chickens are reared. In FRR D (the control), day-old chicks were fed the commercial broiler starter and finisher diet for the entire experimental period of 8 weeks without outside access. All birds had free access to water in round drinkers *ad libitum*. The chemical composition of the commercial broiler starter and broiler finisher diets used in the study is presented in Table 1.

**Table 1:** Experimental layout showing free-range strategy (FRR)

| Group | Age (weeks) at which chickens were allowed free-range access(FRR) | Number of weeks chickens were exposed to free-range system |
|---|---|---|
| A | 2 | 6 |
| B | 3 | 5 |
| C | 4 | 4 |
| D | no exposure | none |

FRR - free-range strategy - age at which chickens were allowed free-range access; FRR A, FRR B and FRR C, day-old chicks were allowed outside/free-range access at 2, 3 and 4 weeks of age, respectively without further supplementation of the starter or finisher diet for the rest of the experimental period; FRR D (the control), day-old chicks were fed the commercial broiler starter and finisher diet for the entire experimental period of 8 weeks without outside access.

**Table 2:** Chemical composition (g/kg) of the commercial broiler starter and finisher diets used in the study*

| Composition (g/kg) | Broiler Starter | Broiler Finisher |
|---|---|---|
| DM | 120.0 | 120.0 |
| CP | 200.0 | 160.0 |
| EE | 25.0 | 25.0 |
| CF | 50.0 | 70.0 |
| Lysine | 12.0 | 9.0 |
| Ca | 12.0 | 12.0 |
| P | 6.0 | 5.0 |

*Supplied by Isinya Feeds Limited, Kilifi, Kenya

The free-range/outside access entailed weaning the chicks from the conventional broiler diet and allowing them to forage outside their pens. Each pen was supplemented with approximately 100 g of kitchen waste to mimic how indigenous chickens are reared. In FRR D (the control), day-old chicks were fed the commercial broiler starter and

finisher diet for the entire experimental period of 8 weeks without outside access. All birds had free access to water in round drinkers ad libitum. The chemical composition of the commercial broiler starter and broiler finisher diets used in the study is presented in Table 2.

### Sensory Evaluation

Three chickens of average body weight were randomly selected from each pen (experimental unit) and slaughtered at week 6, 7 and week 8 of age. The drumsticks were isolated and were subjected to three methods of preparation i.e., boiling, roasting or frying. The boiled, roasted or fried drumsticks were then cut into 1×1 cm cubes using a knife and each sample placed on individual pre-labelled trays.

Ten graduate students at Pwani University served as the panelists in the sensory evaluation of the meats. Previous researchers comparing similar types of chicken meat sensory evaluation have used 10 panelists (Jahan et al., 2005) and 9 members (Castellini et al., 2002) or 15 to 17 members (Fanatico et al., 2006). The students were trained on sensory evaluation of meat and were asked to rank their preferences of each sample in terms of aroma, flavour and overall acceptability. A 1 to 5 ranking scale for preference was used i.e. 1 was the most disliked or least tasty and 5 the most liked or tastiest.

### Statistical Analysis

The data on sensory evaluation of meat was subjected to analysis of variance (ANOVA) using the GLM procedure (SAS Institute, 1998). However, because this type of data generally follows the Poisson distribution, the data was transformed by taking the square root of the frequencies that the panelists had recorded for each treatment before data analysis (Quinn & Keough, 2002). The statistical model used to analyze the transformed data was:

$$Y = \mu + \alpha + \beta + \varepsilon$$

Where; Y = the square root of the ranking of taste variable on a scale of 1 to 5 where 1 was the most disliked or least tasty and 5 the most liked or tastiest, = the sample mean, $\alpha$ = the effects of method of preparation on the taste of the meat, $\beta$ = the effects of the free-range strategy on the taste of the meat and $\varepsilon$ = error.

Significant differences among treatment means were separated using the Duncan's multiple range test at a significance limit of $P < 0.05$.

## RESULTS

The effect of free-range strategy on aroma of meat at different ages of slaughter is presented in Table 3. The free-range strategy had significant impact on the aroma of the meat ($P<0.0001$) with the 2-week release i.e. 6 weeks access to free-range being the most preferred and the control being the least preferred. There were no significant differences between the 2-week release (6 weeks access to free-range) and 3-week release (5 weeks access to free-range) except for chickens slaughter at 6 week of age. There were also no significance differences between the 4-week release (4 weeks access to free-range) and the control (no access to free-range) except for chickens slaughter at 8 week of age. Figure 1 shows the general trends on the effects of free-range strategy on the aroma of meat of chicken slaughter at 6, 7 and 8 of age.

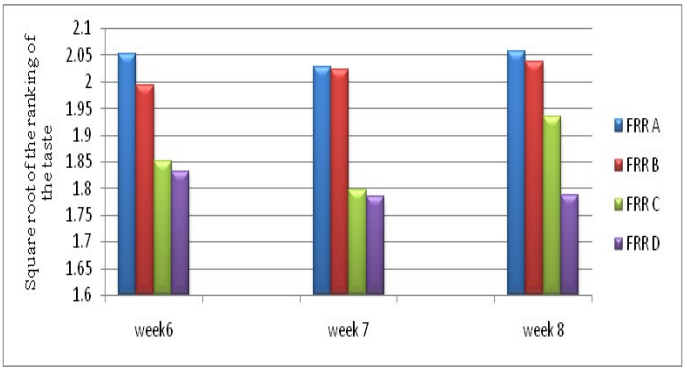


**Figure 1:** Effects of free-range strategy (FRR) on the aroma of meat of chicken slaughter at 6, 7 and 8 of age. FRR - free-range strategy - age at which chickens were allowed free-range access; FRR A, FRR B and FRR C, day-old chicks were allowed outside/free-range access at 2, 3 and 4 weeks of age, respectively without further supplementation of the starter or finisher diet for the rest of the experimental period; FRR D (the control), day-old chicks were fed the commercial broiler starter and finisher diet for the entire experimental period of 8 weeks without outside access.

The effect of free-range strategy on flavour of meat of chicken slaughter at 6, 7 and 8 of age is presented in Table 4. Free-range strategy had a significant effect on the flavour of the meat ($P<0.0001$) although this difference was not evident between the chicken release at 2-week (6 weeks access to free-range) and 3-week (5 weeks access to free-range) and were slaughter at 7 and 8 week of age. There were also no differences between the 4-week release (4 weeks access to free-range) and the control (no access to free-range) for chicken slaughter at 6 and 8 week of age. There was a general decrease in the flavour of the meat from the 2-week release (6 weeks access to free-range) towards the control (no access to free-range). Figure 2 shows the general trends of the effect of free-range strategy on flavour of meat of chicken slaughter at 6, 7 and 8 of age.

**Table 3:** Effects of free-range strategy (FRR) on the aroma of meat of chicken slaughter at 6, 7 and 8 of age.

| Age at slaughter | Aroma | | SE | P value |
|---|---|---|---|---|
| 6 | Free-range strategy | Means | 0.1026 | < 0.0001 |
| | A | 2.0415[a] | | |
| | B | 1.9411[b] | | |
| | C | 1.8339[c] | | |
| | D | 1.8199[c] | | |
| 7 | A | 2.0464[a] | 0.0960 | < 0.0001 |
| | B | 2.0337[a] | | |
| | C | 1.8137[b] | | |
| | D | 1.8113[b] | | |
| 8 | A | 2.0390[a] | 0.0933 | < 0.0001 |
| | B | 2.0338[a] | | |
| | C | 1.9466[b] | | |
| | D | 1.8187[c] | | |

FRR - free-range strategy - age at which chickens were allowed free-range access; FRR A, FRR B and FRR C, day-old chicks were allowed outside/free-range access at 2, 3 and 4 weeks of age, respectively without further supplementation of the starter or finisher diet for the rest of the experimental period; FRR D (the control), day-old chicks were fed the commercial broiler starter and finisher diet for the entire experimental period of 8 weeks without outside access.

[a,b]Means in the same column with different superscripts within slaughter week differ (P < 0.05).

**Table 4:** Effects of free-range strategy (FRR) on the flavour of meat of chicken slaughter at 6, 7 and 8 of age.

| Age at slaughter | Aroma | | SE | P value |
|---|---|---|---|---|
| 6 | Free-range strategy | Means | 0.0916 | < 0.0001 |
| | A | 2.0516[a] | | |
| | B | 1.9924[b] | | |
| | C | 1.8516[c] | | |
| | D | 1.8305[c] | | |
| 7 | A | 2.0273[a] | 0.1017 | < 0.0001 |
| | B | 2.0223[a] | | |
| | C | 1.7981[b] | | |
| | D | 1.7838[b] | | |
| 8 | A | 2.0581[a] | 0.0922 | < 0.0001 |
| | B | 2.0384 [a] | | |
| | C | 1.9348[b] | | |
| | D | 1.7877[c] | | |

FRR - free-range strategy - age at which chickens were allowed free-range access; FRR A, FRR B and FRR C, day-old chicks were allowed outside/free-range access at 2, 3 and 4 weeks of age, respectively without further supplementation of the starter or finisher diet for the rest of the experimental period; FRR D (the control), day-old chicks were fed the commercial broiler starter and finisher diet for the entire experimental period of 8 weeks without outside access.

[a,b]Means in the same column with different superscripts within slaughter week differ (P < 0.05).

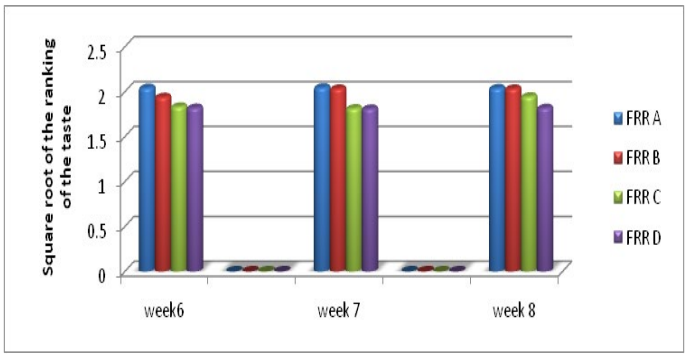


**Figure 2:** Effects of free-range strategy (FRR) on the flavour of meat of chicken slaughter at 6, 7 and 8 of age. FRR - free-range strategy - age at which chickens were allowed free-range access; FRR A, FRR B and FRR C, day-old chicks were allowed outside/free-range access at 2, 3 and 4 weeks of age, respectively without further supplementation of the starter or finisher diet for the rest of the experimental period; FRR D (the control), day-old chicks were fed the commercial broiler starter and finisher diet for the entire experimental period of 8 weeks without outside access.

**Table 5:** Effects of free-range strategy (FRR) on overall acceptability of meat of chicken slaughter at 6, 7 and 8 of age.

| Age at slaughter | Overall acceptability | | SE | P value |
|---|---|---|---|---|
| 6 | Free-range strategy | Means | 0.1026 | < 0.0001 |
| | A | 2.1145[a] | | |
| | B | 2.0071[b] | | |
| | C | 1.8808[c] | | |
| | D | 1.8274[d] | | |
| 7 | A | 2.0906[a] | 0.0916 | < 0.0001 |
| | B | 2.0631[a] | | |
| | C | 1.7893[b] | | |
| | D | 1.7383[c] | | |
| 8 | A | 2.1020[a] | 0.0838 | < 0.0001 |
| | B | 2.0494[b] | | |
| | C | 1.9327[c] | | |
| | D | 1.7987[d] | | |

FRR - free-range strategy - age at which chickens were allowed free-range access; FRR A, FRR B and FRR C, day-old chicks were allowed outside/free-range access at 2, 3 and 4 weeks of age, respectively without further supplementation of the starter or

finisher diet for the rest of the experimental period; FRR D (the control), day-old chicks were fed the commercial broiler starter and finisher diet for the entire experimental period of 8 weeks without outside access.

[a,b]Means in the same column with different superscripts within slaughter week differ ($P < 0.05$).

The effect of free-range strategy on overall acceptability of meat of chicken slaughter at 6, 7 and 8 of age is presented in Table 5. Free-range strategy had a significant effect on overall acceptability, with the 2-week release (6 weeks access to free-range) being the tastiest and the control (no access to free-range) being the least tasty, except for chicken slaughter at 7 week of age where there was no difference between the 2-week release (6 weeks access to free-range) and 3-week release (5 weeks access to free-range). Figure 3 shows the general trends on the effect of free-range strategy on overall acceptability of meat of chicken slaughter at 6, 7 and 8 of age.

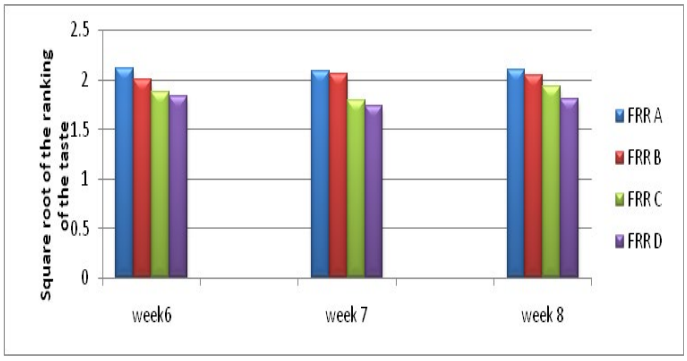


**Figure 3:** Effects of free-range strategy (FRR) on the overall acceptability of meat of chicken slaughter at 6, 7 and 8 of age. FRR - free-range strategy - age at which chickens were allowed free-range access; FRR A, FRR B and FRR C, day-old chicks were allowed outside/free-range access at 2, 3 and 4 weeks of age, respectively without further supplementation of the starter or finisher diet for the rest of the experimental period; FRR D (the control), day-old chicks were fed the commercial broiler starter and finisher diet for the entire experimental period of 8 weeks without outside access.

## DISCUSSION

Meat quality is mainly assessed by its appearance, texture, flavour, and juiciness (Jahan et al., 2005). This study set out to establish whether free-range strategy i.e. access to free-range had any effect on aroma, flavour and overall acceptability of broiler meat. Flavour is a combination of taste and smell (aroma). Human taste buds principally taste sweet, sour-acid, salt, bitter, and umami, because of compounds present in meat (Farmer, 1999). In contrast to the taste compounds, aroma compounds are largely formed by chemical reactions during cooking (Farmer, 1999). Cooked meat flavour is dependent on several factors including the source animal, age, breed, sex, nutritional status, post-mortem ageing, and method of cooking (Liu et al., 2012).

The results showed that free-range strategy had a significant effect on the aroma and flavour of the meat although this difference was not evident between the chicken, which had 6 weeks access to free-range, and those that had 5 weeks access to free-range and were slaughter at 7 and 8 weeks of age. These observations are consistent with the findings of Jahan et al. (2005) who reported that increase in the age of the chicken is associated with increase in the meat flavour and aroma in broiler chickens. Latter-Dubois (2001), Fanatico et al. (2005) and Wang et al. (2009) also found that meat from chicken in free-range was tastier than that of birds from the conventional intensive broiler production systems. However, the difference in the aroma and flavour of the meat between the chicken which had 6 weeks access to free-range and those that had 5 weeks access to free-range was not significant unless other factors of production like cost are considered. No differences were observed between chickens that had 4 weeks of access to free-range and those that had no access to free-range at the slaughter age of 6 and 7 weeks which equates to 2 and 3 weeks respectively of free-range access but the differences were significant at slaughter age of 8 weeks suggesting the longer the birds free-range access the tastier was the meat.It has been shown that meat flavour increases with age, likely because of the increased concentration of nucleotides in muscle, which degrade to inosinic acid and hypoxanthine after slaughter (Aberle et al., 2001; Tikk et al., 2006). Vani et al. (2006) has reported that variations in nucleotide content in muscles can be due to the differences in species, breed, age, sex etc. In the current study, the only variable was age since the species, breed and sex of the chicks was held constant. Meat from animals that have the opportunity to exercise, including game animals, has better flavour because inosine monophosphate and its degradation products, ribose and hypoxanthine enhances flavour formation and development (Aberle et al., 2001). In this study, the birds had outside access at different timelines. Consequently, they had an opportunity to exercise which may be why their meat tasted better than that of the conventional broilers. Besides the natural compounds in meat, the diet of the bird contributes to the flavour (Perez-Alvarez et al., 2010). In the current study, outside access meant that the chicken had access to pasture among other things, which might have enhanced the meat flavour in agreement with Gordon and Charles (2002) who found that some forages, such as rosemary, result in distinctive flavours being impacted on the broiler meat.

The overall acceptability of the meat followed a similar trend. The longer the birds were exposed to outside access the higher was the overall acceptability of the meat in agreement with Castellini et al. (2002) who found that or-

ganic production resulted in better sensory attributes than conventional production in terms of overall acceptability and juiciness.

In conclusion, this research has established that the longer conventional broilers are subjected to outside access without commercial feed supplementation, the tastier was their meat. However there is need to compare these results with those for indigenous chicken and different fast growing breeds e.g. Cornish Rock and Rosambro breeds to determine the factors that will produce the most desirable flavor from the standpoint of the consumer.

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## CONFLICT OF INTEREST

This manuscript has not been submitted for publication elsewhere and been approved by all co- authors. The authors declare that they have no conflict of interest.

## AUTHORS CONTRIBUTION

All the authors have equal contribution in the development of the manuscript.

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