Importance of Poultry Products for Human Health

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***Abstract*— The main objective of this project was to investigate the effect of enriching broiler meat with polyunsaturated fatty acids (PUFA) from different sources on the organoleptic traits of the produced meat. Flaxseed oil, docosahexaenoic acid (DHA) biomass oil, and flaxseeds as seeds were used. A total of 400, one-day old male Cobb 500 broiler chicks were distributed into four dietary treatments (TRTs). TRT 1 is the control treatment that received a basal diet with soybean oil (SO), TRT 2 included 10% of whole linseeds (LS), TRT 3 included 33.5 gm /kg of algal DHA oil (DHA), TRT 4 included 33.5 gm /kg of linseed oil (LO). Each treatment was replicated five times with 20 birds per replicate. The birds were slaughtered at 35 days of age and the organoleptic study was conducted. The results showed that there were no significant differences observed for the parameters of color, texture, flavor, appearance, smell and overall acceptability. However, significance was obtained for the parameter of taste with control-diet fed broilers producing meat with the most appealing taste and those fed DHA based diets producing the least appealing taste. In conclusion, plant based sources of PUFA such as flaxseeds and flaxseed oil can be safely used to enrich broiler meat with PUFA.**

***Keywords*—broiler, docosahexaenoic acid, flaxseed, polyunsaturated fatty acids.**

I. Introduction

Poultry is of utmost importance as it is an easily available source of protein-rich food worldwide, through its involvement in food production and food availability for consumers [1], [2]. The Food and Agricultural Organization (FAO) has estimated that the world's population will reach nine billion in 2050; currently 805 million people live below the poverty line [3]. This impacts food security in order to meet the demands for nutritious food worldwide. Poultry rearing and production plays an important role in overcoming food insecurities by providing a source of income generation in many developing countries [4-10].

There was a surge in production of poultry meat from 56 million metric tons in 1996 to 114 million metric tons in 2015, this production is estimated to reach 116 million metric tons in 2016 [2]. Poultry meat is the most preferred among different meats, globally which accounts for nearly two thirds of the meats used as a dietary source [11]. The increase in the demand for poultry meat is mainly due to the following factors: 1) increased convenience of chicken products such as skinless, boneless breast, chicken nuggets and other products in the market, 2) chickens lower price relative to red meat, 3) health related concerns about fat, saturated fat and cholesterol levels being less in chicken than in beef [12-20].

Egg production increased by 36.5%, or an average of 2.8% per year all over the world during 2000-2014, with China and the United States holding the position of top egg-producing countries of the world [2]. Around the world, consumption of eggs in 2014 remains higher than a decade ago. This increase is particularly noticeable in developing countries where changing diets have people consuming a greater number of calories from protein sources like poultry meat and eggs [2]. The consumption of eggs in the GCC increased annually at growth of 3.9% between 2006 and 2012. However, production of eggs increased at a faster rate of 5.8% rise annually compared to consumption [5, 10, 21].

Major objectives of poultry research include the following: 1) Optimize production efficiency and improve quality of broilers, broiler breeders and laying hens and their products. 2) Enhance production efficiency of other poultry species, such as quail and ostrich. 3) Provide technical services to poultry companies. 4) Develop national manpower in the areas of poultry science.

Improving the performance production of broilers is a major concern of broiler production companies all over the world. Harsh environmental conditions, such as heat stress, may negatively affect the production performance of broiler chickens. This stress results in the partitioning of nutrients away from growth, and moving toward the physiological process related to heat stress resistance. This will cause decreased production in and profit to commercial poultry companies in the country [22-27].

Polyunsaturated fatty acids (PUFA) are one of the effective ingredients that can be enriched into the poultry products and have beneficial effects on human health when chicken meat and eggs are consumed by human beings. There are different sources of PUFA such as flaxseed, fish oils, and DHA algal biomass. A study was done to evaluate the organoleptic characteristics of broiler meat enriched with PUFA from various sources.

II. Materials and Methods

A. Organoleptic Study of the Produced Broiler Meat

This included testing the taste/acceptability of the meat

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samples to determine the effect of dietary treatments on the sensory quality of the produced meat. The meat was simply cooked with minimal spices to ensure that the chicken meat is edible and acceptable by panelists. Sensory evaluation parameters included acceptability and palatability tests of the poultry meat. This was done by taste paneling and visual observations (Fig. 1 and 2). There were 20 panelists. The panelists who participated in the sensory evaluation were trained on the method before they began the procedure. Each group of meat samples was labeled randomly with a two-digit code number. Each batch of samples was presented in a randomized order, and the panelists were asked to assign scores for color, smell, texture, taste, and general acceptability on a structured nine-point hedonic scale (1 to 9 scale, where 1 indicated the worst and 9 indicated the best quality). In this method, the stimuli (meat samples) are presented individually and are rated on a scale where the 9 categories range from "dislike extremely" to "like extremely”. The major advantages of this method are: participant can respond meaningfully without prior experience, it was suitable for use with a wide range of populations, the data can be handled by the statistics of variables, and results are meaningful for indicating the general levels of preference [28]. The surveys presented to panelists included brief instructions and a short definition of the study attributes. The testing was carried out in a room at 24^{o}C, separate from the cooking area and under normal light to avoid visual differences in yolk and albumin color. The testing was scheduled from 11:00 am to 2:00 pm.

B. *Statistical Analysis*

The overall differences between the dietary treatments were analyzed using ANOVA, and the general linear model procedure of Minitab was applied. Differences between the treatment groups were considered statistically different at $P \leq 0.05$. When significant differences occurred ($P \leq 0.05$), treatment means’ differences were identified by pairwise comparison using the Bonferroni test..

C. *Figures*

Fig. 1. The cooked broiler meat samples prepared for the taste paneling

Fig. 2. Taste panelists sampling the different broiler meat samples

III. Results

Table 1 shows the quality evaluation of the broiler meat from broilers fed the different dietary treatments. For further illustrating the results, different parameters have been shown in Figs. 3–9.

In terms of color, no significant differences were observed. However, the results showed that broilers fed control diets produced the most acceptable color with the least acceptable being those fed FLO diets (Fig. 3.). No significance was observed for broiler meat texture, but it was the best for broilers fed FLO and DHA (Fig. 4.). Similarly, no significant differences were observed for flavor, although control-diet fed broilers produced meat with the most acceptable flavour (Fig. 5.). Control and DHA fed broilers were the most appealing in terms of appearance (Fig. 6.), but no significance was observed. Similarly, in terms of smell (Fig. 7.), there was no significance but the smell was acceptable for control diets. However, significant differences ($P<0.05$) were observed for the taste parameter (Fig. 8.); broilers fed control-based diets had the most appealing taste and those fed DHA had least appealing taste. Broilers, when fed control diets, produced overall acceptability (Fig. 9.) for most parameters of the organoleptic study (Table 1), but no significance was observed.

TABLE I. ORGANOLEPTIC EVALUATION OF BROILER MEAT

	Treatments				
Organoleptic Parameters	Control	FLS	FLO	DHA	P-value
Color	7.65 ± 1.46	6.94 ±1.03	6.88 ±2.20	7.00 ±1.22	0.444
Texture	6.18 ±2.16	6.47 ±1.62	6.59 ±1.84	6.59 ±2.21	0.920
Flavor	7.12 ±1.65	5.59 ±1.94	6.06 ±1.98	5.76 ±1.71	0.077
Appearance	6.59 ±2.00	6.53 ±1.70	6.41 ±2.12	6.59 ±1.33	0.991
Smell	6.41 ±1.73	6.06 ±1.78	5.59 ±1.58	5.29 ±1.72	0.242
Taste	7.24^{a}±1.35	6.47^{ab}±1.28	6.06^{a}±1.68	4.82^{b}±1.91	<0.001
Overall acceptability	7.06 ±0.83	6.71 ±0.99	6.65 ±1.32	6.18 ±1.51	0.204

FLS= Flaxseeds; FLO= Flaxseed oil; DHA= Docosahexaenoic acid.
Differences between the treatment groups are statistically different at $P \leq 0.05$

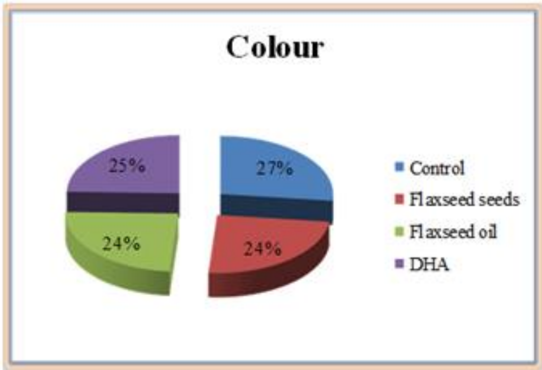

Fig. 3. Color evaluation of the meat samples from broilers fed various experimental diets

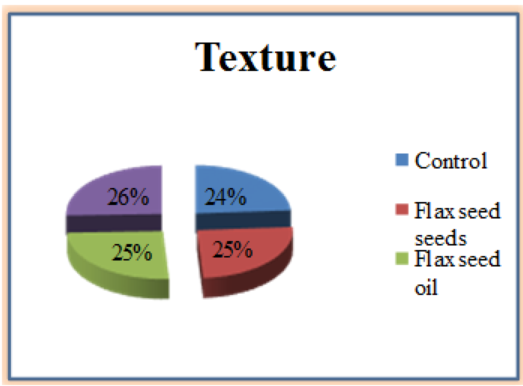

Fig. 4. Texture evaluation of the meat samples from broilers fed various experimental diets

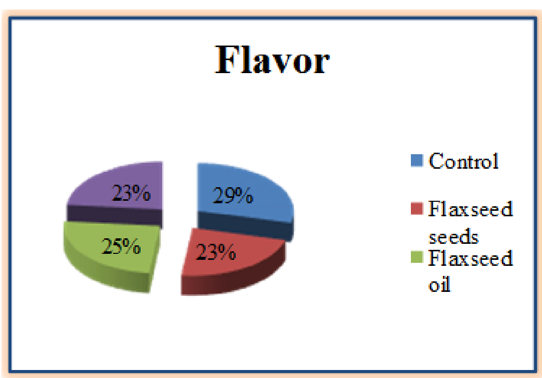

Fig. 5. Flavour evaluation of the meat samples from broilers fed various experimental diets

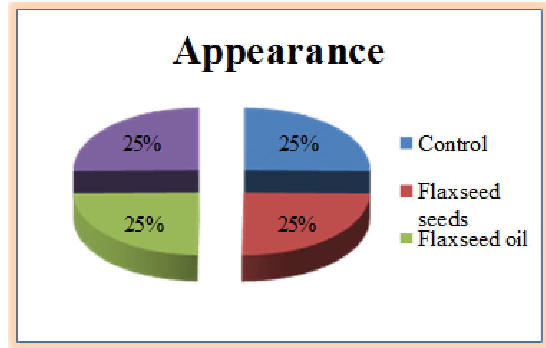

Fig. 6. Appearance evaluation of the meat samples from broilers fed various experimental diets

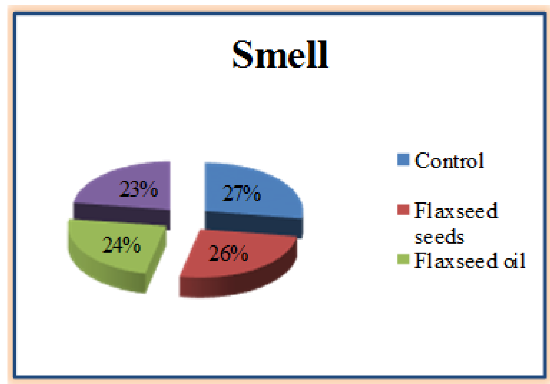

Fig. 7. Smell evaluation of the meat samples from broilers fed various experimental diets

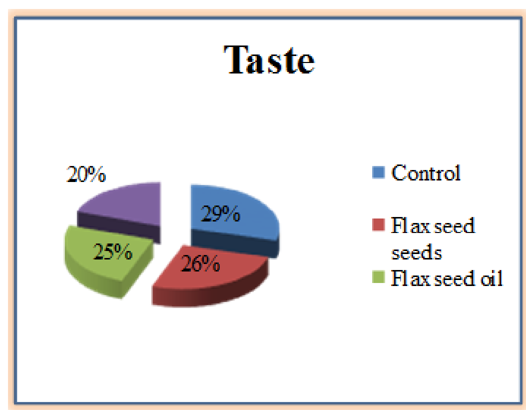

Fig. 8. Taste evaluation of the meat samples from broilers fed various experimental diets

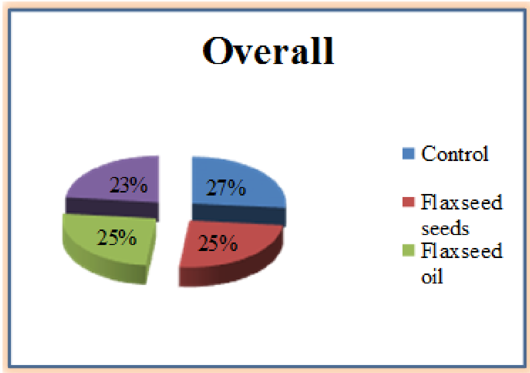

Fig. 9. Overall evaluation of the meat samples from broilers fed various experimental diets.

IV. Discussion

In recent years, PUFA have received considerable attention in both human and animal nutrition, particularly those of the n-3 family. These are PUFA in which the first double bond is situated on the third carbon atom from the methyl end of the fatty acid molecule. Consumption of n-3 PUFA are low, particularly the long chain (>18 carbon atoms) ones that are most commonly found in fish oils. As a mean of increasing the low consumption of the long chain n-3 PUFA by humans consuming western diets, there has been some interest in the enrichment of poultry meat with these fatty acids for people seeking healthy lifestyles.

Vitality of living cells depends profoundly on dietary lipids that are incorporated into phospholipid layers of cellular membranes. n-3 PUFA, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are reported to compete with arachidonic acid (AA) for this incorporation. Since AA is responsible for up-regulation of eicosanoids such as leukotrienes, this competitive inhibition down-regulates inflammation responses related to many diseases and disorders such as cardiovascular disease, increased triglycerides, blood pressure, thrombosis, atherosclerosis, stress, mental problems, asthma and rheumatoid arthritis [29, 30]. These benefits of an optimal ratio of n-3/n-6 PUFAs on health are just a few examples of a wide range of clinical problems that are improved by consumption of the very long chain n-3 fatty acids.

Traditionally, fish and fish oil are the main sources of essential, long chain n-3 PUFA that induce modifications in the lipid composition of poultry products because marine sources in general contain high levels of EPA and DHA PUFA. Of less nutritional importance are plant sources such as linseed that is rich in α-linolenic acid (α-LNA). α-LNA is an 18 carbon n-3 fatty acid that is the precursor to the long chain n-3 PUFA, but because the efficiency of conversion is so low in humans, the accumulation of α-LNA is of little real nutritional benefit. Chickens fed linseed oil deposit significant amounts of α-LNA in the egg yolk (in laying hens) and meat (in broilers) [31]. However, to achieve enrichment of poultry products with long chain n-3 PUFA, marine oils need to be fed. Bou et al. [32] reported that supplementing broiler diets with 25 g/kg fish oil produced double the amount of beneficial EPA and DHA than diets supplied with 12.5 g/kg fish oil. High concentrations of fish oil supplementation decrease the saturated and monosaturated FA and increase the very long chain PUFA in poultry meat [33]. Lopez-Ferrer et al. [34] substituted 82 g/kg fish oil in supplemented broilers diet with the same amount of linseed and rapeseed. They concluded that the total amount of the very long chain PUFA in the chicken meat decreased when fish oil was removed from the diet. On the contrary, the n-6 PUFA and monosaturated FA in form of oleic acid increased. These results support the fact that fish oil is more efficient in elevating levels of long chain n-3 PUFA [19, 35-38].

V. Conclusion

Chicken meat represents a good source of nutrients and effective ingredients for humans. It could be enriched with PUFA to add more nutritional value to it. Organoleptic studies on the broiler meat showed that there were no significant differences observed for the parameters of color, texture, flavor, appearance, smell and overall acceptability. However, significance was obtained for the parameter of taste with control-diet fed broilers producing meat with the most appealing taste and those fed DHA based diets producing the least appealing taste.

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