

Effect of feeding broiler chicken on soybean oil and palm oil supplemented with some feed additives on the quality characteristics of processed chicken nuggets

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Abstract— The objective of this study was to investigate the effect of feeding broiler chicken on different vegetable oils with feed additives on the quality characteristics of chicken nuggets. A total of 216 one-day-old chicks of (Hubbard) strain were randomly assigned to six dietary treatments as (2×3) factorial designs where two sources of dietary oil contained soybean oil and palm oil with three levels of commercial multi-enzyme feed additives. Treatments were: soybean oil only (T1), soybean oil+ ZAD (T2), soybean oil+ AmPhi-BACT (T3), palm oil only (T4), palm oil + ZAD (T5) and palm oil + AmPhi- BACT (T6). Results showed that chicken nuggets of T3 group had the higher pH value. No significant differences were found in cooking loss between (T1, T5 and T6) and nuggets of T3 and T4. Nugget of T2 group had the higher T.B.A value. No significant effect on shrinkage % of nuggets samples.

Keywords— Broiler feed, Vegetable oils, Feed additives, Chicken nuggets, Quality characteristics.

I. INTRODUCTION

Chicken meat contains a high protein and low fat content and deliberated as the principal source of polyunsaturated fatty acids (PUFA) with paramount concentration of n-3 PUFA (Howe *et al.*, 2006).

Chicken has been considered an appropriate model in lipid nutrition studies, since it is highly sensitive to dietary fat modifications and many of the studies done with chickens deal with the degree of saturation or source type of the dietary replaced fat and how it influences the performance and carcass quality improvement of the animal (Rymer and Givens, 2005).

Using soybean and palm oil in poultry rations would subsequently affect human health in a positive manner by increasing 18:2 and 18:3 fatty acid contents in animal product without any negative effects on meat quality (Ayed

et al., 2015). Palm oil can be used as a vegetable oil in broiler chicken nutrition with positive effects on firmness of meat quality compared with soybean oil and linseed oil (Abdulla *et al.*, 2015).

Commercial enzyme preparations have been used widely to enhance nutritive value of wheat and rye-based diets because of high insoluble non-starch polysaccharides found in these feedstuffs which induce high digesta viscosity (Lázaro *et al.*, 2003). Inclusion of exogenous enzyme in animal's diet has been shown to improve broiler's performance. But the effect on meat quality has to be determined as certain feed additives have been found to affect meat quality (Wang, *et al.*, 2013; Omojola, *et al.*, 2014).

Therefore, this research aims to study the effect of using different vegetable oil sources and feed additives in finisher diets of broiler chicken, on the quality characteristics and lipid oxidation of processed chicken nuggets.

II. MATERIAL AND METHOD

2.1 Experimental Design

The experimental procedures were approved by the Poultry Production Department, Faculty of Agriculture, Ain Shams University and as followed by the Animal Breeding Department, Animal and Poultry Production Division, Desert Research Center.

The current study was conducted at Poultry Experimental Unit, Faculty of Agriculture, Ain Shams University, located in Agricultural Research Station, Shalaqan, Qalyobia Governorate, Egypt. The experiment was a 2 × 3 factorial design with two sources of vegetable oils (soybean oil and palm oil) with three levels of commercial multi-enzyme feed additives as shown in the Table (1).

Table.1: Experimental design

Type of oil	Feed additives		
	Without addition	ZAD ¹ 0.5kg/ton	AmPhi-BACT ² 0.5kg/ton
Soybean oil	Treatment 1 (T1)	Treatment 2 (T2)	Treatment 3 (T3)
Palm oil	Treatment 4 (T4)	Treatment 5 (T5)	Treatment 6 (T6)

¹ (ZAD) which contains bacteria (*Ruminococcusflavefaciens*) with concentration of (28 x 10⁴). Also it contains a mixture of enzymes (Cellulase - Xylanase - α -Amylase -Protease).

²(AmPhi-BACT), which contains bacteria (*Lactobacillus acidophilus*) and (*Lactobacillus planterum*) and (*Bifidobacterium bifidum*) and extract ferment of both (*Bacillus subtilus*) and (*Aspergillusniger*) with concentration of 5 g / kg and also contains a mixture of enzymes that is estimated as 34.5 units / gram, that is equivalent to 2 g / kg (Cellulase - Beta-glucanase - Hemicellulase).

A total of 216 one-day-old chicks of (*Hubbard*) strain were used for this study, the chicks were randomly assigned to six treatment groups. Each group consisted of six replicates and each replicate was made up of six chicks. The basal diet

was formulated to meet the nutrient requirements of broiler chicken following the National Research Council (NRC, 1994) as shown in Table (2).

Table.2: Feed ingredients and chemical analyses of experimental diets

Ingredients	Starter	Grower	Finisher (23-35)					
	(0-11)	(12-22)	T1	T2	T3	T4	T5	T6
Corn (grains)	52.05	55.91	56.80	56.80	56.80	56.80	56.80	56.80
Soybean Meal (44%)	31.50	30.00	28.25	28.25	28.25	28.25	28.25	28.25
Corn Gluten Meal (62%)	7.20	4.86	4.40	4.40	4.40	4.40	4.40	4.40
Soybean Oil	3.00	3.65	5.00	5.00	5.00	-	-	-
Palm Oil	-	-	-	-	-	5.00	5.00	5.00
Wheat Bran	2.00	1.50	2.00	2.00	2.00	2.00	2.00	2.00
Di-Calcium Phosphate	1.85	1.60	1.34	1.34	1.34	1.34	1.34	1.34
Calcium Carbonate	1.30	1.50	1.35	1.35	1.35	1.35	1.35	1.35
Premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
DL-Methionine	0.29	0.28	0.21	0.21	0.21	0.21	0.21	0.21
L-Lysine HCL	0.21	0.10	0.05	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100	100	100	100
Nutrient content (Calculated) **								
Crude Protein %	23.00	21.00	20.00	20.00	20.00	20.00	20.00	20.00
Crude Fat %	5.69	6.39	7.76	7.76	7.76	7.76	7.76	7.76
Crude Fiber %	3.88	3.75	3.70	3.70	3.70	3.70	3.70	3.70
ME Kcal/ Kg diet	3029	3076	3171	3171	3171	3171	3171	3171
Calcium %	1.00	1.01	0.90	0.90	0.90	0.90	0.90	0.90
Available Phosphorus %	0.50	0.45	0.40	0.40	0.40	0.40	0.40	0.40
Lysine %	1.30	1.15	1.06	1.06	1.06	1.06	1.06	1.06
Methionine &Cystein %	0.97	0.93	0.84	0.84	0.84	0.84	0.84	0.84

* Each 3 Kg of premix contains: Vitamins: A: 12000000 IU; Vit. D3 2000000 IU; E: 10000 mg; K3: 2000 mg; B1:1000 mg; B2: 5000 mg; B6:1500 mg; B12: 10 mg; Biotin: 50 mg; Coline chloride: 250000 mg; Pantothenic acid: 10000 mg; Nicotinic acid: 30000 mg; Folic acid: 1000 mg; Minerals: Mn: 60000 mg; Zn: 50000 mg; Fe: 30000 mg; Cu: 10000 mg; I: 1000 mg; Se: 100 mg and Co: 100 mg.

** Nutrient content calculated based on chemical analysis data of feedstuffs provided by NRC (1994).

- Starter: one-day-old till 11 days-of-age (basal diet – without additives - all birds).
- Grower: 12 days till 22 days (basal diet - without additives - all birds).
- Finisher: 23 days till 35 days (experimental diets specified per treatment).

Chicks were housed in galvanized cages, where nine birds were allotted to a pen cage of 100 cm long, 40 cm width and 40 cm height. The farm building was aerated naturally. Lighting program was controlled to provide 23 hours light and one hour dark daily by candescent bulb lighting system. Room temperature was maintained around 32° C for the first week and was decreased by 3° C weekly afterwards.

At the end of experiment, four chickens were randomly selected for slaughtering from each treatment to use in the processing of chicken nuggets. Slaughtered birds were scalded in hot water bath, plucked and eviscerated manually. Chicken meat from thigh and abdominal muscles were collected, packed and frozen at -18°C until further analyses and processing of chicken burger were completed.

2.2 Preparation of chicken nuggets

Chicken meat from each experimental diet was ground through a 3mm plate grinder. Chicken nuggets samples were prepared as follows ingredients; wheat flour 3%, Condiments 3%, black pepper 2%, Salt 1.5%, and Ice flakes 8% as describe by (Nayak *et al.*, 2015). Batches of 2kg of each dietary treatment were mixed and formed by hand into circular (1 cm thicknes, 5 cm diameter and 25±2g weight). Nuggets were placed in plastic foam trayspacked in polyethylene bags and frozen at -18°C±1until further analysis.

2.3 Physical analysis

2.3.1 pH value

pH of raw chicken nuggets was measured as described by Hood(1980). Ten grams of sample was homogenized with 100ml distilled water and measured using a digital pH-meter Jenway 3310 conductivity and pH meter. pH values were done on four replicates per treatment. Two nuggets were used for each replication.

2.3.2 Cooking measurements

Chicken nuggets samples of each treatment were dipped sequentially in plain flour and bread crumbs and fried in corn oil at 180 °C till golden brown in color. All cooking measurements were done on four replicates per treatment. For each replication three nuggets were examined for cooking loss, reduction in thickness, reduction in diameter and shrinkage.

The cooking loss was determined as reported by Naveena *et al.* (2006) as follows:

$$\text{Cooking loss (\%)} = \frac{(\text{Uncooked sample weight}) - (\text{Cooked sample weight})}{(\text{Uncooked sample weight})} \times 100$$

2.3.3 Shrinkage measurements

Raw and cooked samples were measured for diameter and thickness of chicken nuggets as described byBerry (1993) using the following equation: Reduction in diameter (%) = $\frac{(\text{Uncooked sample diameter}) - (\text{Cooked sample diameter})}{(\text{Uncooked sample diameter})} \times 100$

$$\text{Reduction in thickness (\%)} = \frac{(\text{Uncooked sample thickness}) - (\text{Cooked sample thickness})}{(\text{Uncooked sample thickness})} \times 100$$

Shrinkage (%): Dimensional shrinkage was calculated using the following equation as reported by Murphy *et al.* (1975): $\frac{(\text{Raw thickness} - \text{Cooked thickness}) + (\text{Raw diameter} - \text{Cooked diameter})}{(\text{Raw thickness} + \text{Raw diameter})} \times 100$

2.4 T.B.A value

Measurement of lipid oxidation: The extent of lipid oxidation in raw chicken nuggets was assessed by measuring 2- thiobarbituric acid reactive substances (TBARS), as described by AOCS (1998).TBA values were done on three replicates per treatment. Three nuggets were used in each replication.

2.5. Color measurements

Color of raw chicken nuggets samples was measured by Chroma meter (Konica Minolta, model CR 410, Japan) calibrated with a white plate and light trap supplied by the manufacturer (CIE, 1976). The color was expressed as L* (lightness), a* (the redness) and b* (the yellowness). The average of three spectral readings at different locations was obtained for each treatment.

2.6. Statistical analysis

Analysis of variance (ANOVA) was used to test the obtained data using the general linear modeling procedure (SAS, 2000). The used design was one way analysis. Duncan's multiple tests (1955) were applied for comparison of means.

III. RESULTS AND DISCUSSION

Table (3) showed the physiochemical properties of chicken nuggets processed from broiler chicken fed on different types of vegetable oil and feed additives. Chicken nuggets of T3 group had the higher pH value (6.11) followed by nugget of T5 (6.10). Slight differences were found between other nuggets samples.

Table.3: Physicochemical properties of chicken nuggets

Treatments	Parameters		
	pH	Cooking loss (%)	T.B.A (mgMDA/kg)
T1	6.05±0.04 ^{bcd}	16.51±0.89 ^c	0.061±0.016 ^c
T2	6.02±0.03 ^{cd}	27.25±0.49 ^a	0.156±0.004 ^a
T3	6.11±0.02 ^a	22.97±1.55 ^b	0.048±0.008 ^{cd}
T4	6.00±0.03 ^d	21.08±2.71 ^b	0.059±0.005 ^c
T5	6.10±0.03 ^{ab}	15.85±2.29 ^c	0.088±0.001 ^b
T6	6.06±0.06 ^{abc}	14.20±1.02 ^c	0.035±0.006 ^d
SEM	0.01	0.97	0.004

^{a-d} means within the same column with different superscripts letters are different (p<0.05). T1, T2 and T3: Treatments for soybean oil/ soybean oil with ZAD 0.5kg/ton and soybean oil with AmPhi-BACT 0.5kg/ton. T4, T5 and T6: Treatments for palm oil/ palm oil with ZAD 0.5kg/ton and palm oil with AmPhi-BACT 0.5kg/ton. Means ± standard deviation. SEM: standard error of means.

Pekel *et al.* (2012) found that the pH of breast meat did not differ between broilers that were fed soybean oil (SO) and the neutralized sunflower soapstock (NSS) diet. Addition of commercial multi-enzyme feed additives had a significant effect on pH value of nugget processed from broiler chicken fed on soybean oil (T2 and T3), while no significant difference were found on those fed on palm oil (T5 and T6). These results are close to that obtained by Zakaria *et al.* (2010) they reported that enzymes addition had no effect on pH value of broiler chicken meat. However the effect of dietary enzyme on pH value of chicken meat was difficult to understand.

Data of cooking loss of chicken nuggets processed from broiler chicken fed on different types of vegetable oil and feed additives indicated that nugget of T2 group had the higher cooking loss. No significant differences were found in cooking loss between (T1, T5 and T6) and nuggets of T3 and T4. These results are close to that obtained by Pekel *et al.* (2012) they indicated that dietary fat source did not affect cooking loss of chicken meat.

As can be seen, addition of commercial multi-enzyme feed additives with palm oil had a significant effect on cooking loss of T2 and T3 nuggets, while addition of feed additives with palm oil had no significant effects on cooking loss of T5 and T6 nuggets. Omojola *et al.* (2014) found that chicken fed diets containing sesame and soybean diet supplemented with enzymes had higher cooking loss than those on sesame

and soybean diet without enzymes. While, Zakaria *et al.* (2010) found that dietary enzyme had no effect on cooking loss of broiler chicken meat.

Data of T.B.A value of nuggets processed from broiler chicken fed on different types of vegetable oil and feed additives were showed in Table (3). Nugget processed from T2 group had the higher T.B.A value followed by nugget of T5, while the lowest T.B.A value found in nuggets of T6 group. No significant differences were found in T.B.A value of other nugget samples (T1, T3 and T4). These results are close to that obtained by Abdulla *et al.* (2015) they found that a significant difference in lipid oxidation was observed among the dietary oils. Breast muscles from broilers fed a diet supplemented with palm oil had a lower TBARS value compared with soybean oil. Also, Pekel *et al.* (2012) found that no significant differences were found in T.B.A value of thigh meat from broilers fed diets with different levels of fat from soybean oil or neutralized sunflower soapstock.

Data in Table (4) showed the shrinkage measurements of chicken nuggets processed from broiler fed on different types of vegetable oil and feed additives. Nugget of T2 group had the higher reduction in diameter; slight significant differences were found in nugget of T1 group and nugget of T3 group. Also, no significant differences were found in nuggets samples of other dietary treatments T4, T5 and T6).

Table.4: Shrinkage measurements of chicken nuggets

Treatments	Parameters (%)		
	Reduction in diameter	Reduction in thickness	Shrinkage
T1	14.13±1.40 ^b	12.28±1.47 ^c	17.93±0.76 ^a
T2	16.99±1.25 ^a	17.16±2.13 ^a	19.44±1.39 ^a
T3	15.56±0.36 ^{ab}	16.88±1.02 ^a	19.24±1.28 ^a
T4	14.38±1.65 ^b	14.69±0.37 ^b	18.43±1.40 ^a
T5	13.84±0.45 ^b	13.82±0.05 ^{bc}	17.73±0.63 ^a
T6	13.44±1.36 ^b	12.04±0.95 ^c	17.16±1.30 ^a
SEM	0.68	0.69	0.67

^{a-c} means within the same column with different superscripts letters are different (p<0.05).

T1, T2 and T3: Treatments for soybean oil/ soybean oil with ZAD 0.5kg/ton and soybean oil with AmPhi-BACT 0.5kg/ton. T4, T5andT6: Treatments for palm oil/ palm oil with ZAD 0.5kg/ton and palm oil with AmPhi-BACT 0.5kg/ton. Means ± standard deviation. SEM: standard error of means.

From the same Table (4), it can be found that no significant differences were found in the reduction in thickness% of nuggets of T2 and T3 groups and nuggets of T1and T6 groups. Slight significant difference was found in nuggets ofT4 andT5. Addition of vegetable oils and commercial multi enzymes feed additives had no significant effect on shrinkage % of nuggets samples. These results are consonance with that obtained by Omojola *et al.* (2014) they reported that there was no significant effect on the meat characteristics of broiler chickens fed on diets (soybean and sesame) supplemented with or without microbial phytase. Also, Dalólio *et al.* (2015) found that enzyme supplementation in diets based on corn and soybean meal did not influence the parameters of chicken meat quality. The same results were found by Pekel *et al.* (2012). Color measurements of chicken nuggets fed on different dietary oils and commercial multi- enzyme feed additives

shown in Table (5). No significant differences were found in *L** value between dietary treatments except for nugget of T1. Also, data showed no significant differences were found in *a** value between nuggets of T1, T3and T4.Slight difference was found between nuggets of T5and T6.No significant differences were found in *b** value between nuggets of T2, T4 and T6. The differences between the other nuggets samples were not significant. These results are close to that obtained by Pekel *et al.* (2012) they found that breast meat color were not affected by the dietary fat source. Also, Zakaria *et al.* (2010) they reported that dietary enzyme had no effect on the broiler chicken meat color. Dalólio *et al.* (2015) found that enzyme supplementation in diets based on corn and soybean meal did not influence the color parameters of chicken meat.

Table.5: Color measurements of chicken nuggets

Treatments	Parameters		
	<i>L</i>	<i>a</i>	<i>b</i>
T1	58.97±0.89 ^b	4.05±1.33 ^{ab}	15.29±0.66 ^c
T2	63.35±1.15 ^a	4.62±0.87 ^a	17.27±0.62 ^a
T3	56.67±0.68 ^a	4.09±0.15 ^{ab}	15.94±0.28 ^{bc}
T4	62.21±2.16 ^a	4.11±0.35 ^{ab}	17.03±0.14 ^a
T5	63.56±2.05 ^a	3.52±0.33 ^{bc}	15.98±0.35 ^b
T6	63.18±1.16 ^a	2.79±0.08 ^c	16.76±0.39 ^a
SEM	0.87	0.28	0.21

^{a-c}Means within the same column with different superscripts letters are different (p<0.05). T1, T2 and T3: Treatments for soybean oil/ soybean oil with ZAD 0.5kg/ton and soybean oil with AmPhi-BACT 0.5kg/ton. T4, T5andT6: Treatments for palm oil/ palm oil with ZAD 0.5kg/ton and palm oil with AmPhi-BACT 0.5kg/ton. Means ± standard deviation. SEM: standard error of means.

IV. CONCLUSION

The purpose of the current study was to evaluate the quality characteristics of chicken nuggets processed from broiler chicken fed on different type of vegetable oils and feed additives. The addition of soybean oil and palm oil as fat sources for use in chicken diets in combination with feed additives (enzymes) had no negative effects on the quality characteristics of chicken nuggets.

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