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Article

Quality characteristics of chicken burger processed from broiler chicken fed on different types of vegetable oils and feed additives

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Abstract

The objective of this study was to investigate the effect of feeding broiler chicken on different vegetable oils with commercial multi- enzyme feed additives on the quality characteristics of chicken burger. 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 burger of T1 group had the higher pH value (6.22); slight difference was found in pH value of T3 group (6.18). No significant difference was found in burger of T5 and T6 group. Burger processed from T1 group had the higher T.B.A value (0.115) followed by burger of T5 (0.076); while the lowest T.B.A value found in burger of T2 group (0.031). No significant differences were found in shrinkage measurements. Burger processed from T6 group had the higher score of sensory attributes and overall acceptability, while the differences between the other burger groups were not significant.

KEYWORDS

Broiler feed, Fat source, Feed additives, Chicken burger, Quality characteristics.

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1 Introduction

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). Vegetable oils are a widely used source of energy in broiler diets. However, most of the vegetable oils are mainly used for human consumption and also for biodiesel production. In this regard, interest is growing in using alternative fat sources in poultry nutrition rather than using crude oil sources, which would increase competition between bio fuel industry and food and feedstuff markets. Palm oil or mixtures of palm oil, fatty acids distilled from the palm and calcic soap are sources of vegetal oils with a fatty acid profile that might replace animal fats without any kind of negative impact on carcass quality (Rodriguez et al., 2002). The inclusion of soybean oil in broiler diets does not affect the moisture and ether extract in the breast and thigh muscles. Furthermore, the deposition of fat on the breast muscle and viscera is not affected by the inclusion of the oil in the diet. Dietary fat quality not only affects animal growth performance and health (Lin et al., 1989; Enberg et al., 1996) but also influences the quality of broiler meat and meat products (Lin et al., 1989; Asghar et al., 1989). Lipid oxidation is a major cause of quality deterioration in meat and meat products and can give rise to rancidity and the formation of undesirable odours and flavours, which affect the functional, sensory, and nutritive values of meat products (Gray et al., 1996).

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). Additionally, it was reported that enzyme cocktail feed additives improve bird's productivity (Saleh et al., 2005) and digestibility of corn-soybean meal based diets, which in turn, induces less viscosity of ingested feed for broilers (Olukosi et al., 2007).

Enzyme such as microbial phytase has been used as commercial feed additive in broiler feed production to improve nutritive values of plant based diets. Addition of microbial phytase to broiler diet leads to hydrolysis of phytase, which bind phosphorus of the plant based diet (Kies, et al., 2001). Moreover, interest in the use of phytase as feed additive has now increased due to problems posed by phosphates in animal wastes. 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 qualities (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 processing of chicken burger and its impact on the quality characteristics.

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2 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	**ZAD1 0.5kg/ton**	**AmPhi-BACT2 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 (Ruminococcus flavefaciens) 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 (Aspergillus niger) 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.

- *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 burger. 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.

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Table 2: Feed ingredients and chemical analyses of experimental diets

Ingredients	Starter (0-11)	Grower (12-22)	Finisher (23-35)					
			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).

2.2 Preparation of chicken burger

Chicken meat from each experimental diet was ground through a 3mm plate grinder. Chicken burger samples were prepared as follows ingredients; 7.5% onion, 0.5%black pepper, spices0.5%, salt 1.5% (Mikhail et al., 2014). Batches of 2kg of each dietary treatment were handily mixed and formed by using manual burger press machine (1cm thickness, 10cm diameter and 60±2g weight). Burgers were placed in plastic foam trays packed in polyethylene bags and frozen at -18°C±1until further analysis.

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2.3 Physical analysis

2.3.1 pH value

pH of raw chicken burger 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 three replicates per treatment. Two burgers were used for each replication.

2.3.2 Cooking measurements

Chicken burger samples of each treatment were cooked in preheated grill at110°C (to an internal temperature 72°C±2). All cooking measurements were done on four replicates per treatment. For each replication three burgers 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:

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

2.3.3 Shrinkage measurements

Raw and cooked samples were measured for diameter and thickness of chicken burger as described by Berry (1993) using the following equation:

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

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

Dimensional shrinkage was calculated using the following equation as reported by Murphy et al. (1975):

$$Shrinkage\ (\%) = \frac{[(Raw\ thickness\ -\ Cooked\ thickness)\ +\ (Raw\ diameter\ -\ Cooked\ diameter)]\ \times 100}{(Raw\ thickness\ +\ Raw\ diameter)}$$

2.4 T.B.A. value

Measurement of lipid oxidation: The extent of lipid oxidation in raw chicken burger 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 burgers were used in each replication.

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2.5 Sensory evaluation

Chicken burger was subjected to organoleptic evaluation as described by AMSA (1995). Ten trained panelists of staff members of Food Sciences Department, Faculty of Agriculture, Ain-Shams University were scored appearance, texture, juiciness, flavour, tenderness and overall acceptability using a 9-point hedonic scale. The mean scores of the obtained results of organoleptic evaluation were then statistically analyzed.

2.6 Statistical analysis

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

3 Results

Table 3 showed the physiochemical properties of chicken burger processed from broiler chicken fed on different types of vegetable oil and feed additives. Chicken burger of T1 group had the higher pH value (6.22); slight difference was found in pH value of T3 (6.18) burger. No significant difference was found in burger of T5 and T6 group. However, burger of T2 and T4 group had the lower pH value (6.05).

Table 3: Physicochemical properties of chicken burger

Treatments	Parameters		
	pH	Cooking loss (%)	T.B.A (mgMDA/kg)
T1	6.22 ± 0.06^{a}	36.21±2.95^{a}	0.115± 0.010^{a}
T2	6.05±0.03^{c}	32.48±2.29^{ab}	0.031±0.017^{d}
T3	6.18± 0.01^{ab}	31.75±4.37^{b}	0.061±0.011^{c}
T4	6.05±0.04^{c}	31.68±2.20^{b}	0.063±0.010^{c}
T5	6.14± 0.015^{b}	34.29±0.68^{ab}	0.076±0.010^{b}
T6	6.14±0.02^{b}	35.83±1.53^{a}	0.065±0.010^{c}
SEM	0.020	1.30	0.003

$^{a-d}$ 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, 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

Data of cooking loss of chicken burger processed from broiler chicken fed on different types of vegetable oil and feed additives indicated that burger of T1 and T6 groups had the higher cooking loss, followed by burger of T2 and T5. No significant differences were found in burger of T3 and T4.

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Data of T.B.A value of burger processed from broiler chicken fed on different types of vegetable oil and feed additives were showed in Table 3. Burger processed from T1 group had the higher T.B.A value followed by burger of T5, while the lowest T.B.A value found in burger of T2 group. No significant differences were found in T.B.A value of other burger samples (T3, T4 and T6).

Data in Table 4 showed the shrinkage measurements of chicken burger processed from broiler fed on different types of vegetable oil and feed additives. Burger of T1 group had the higher reduction in diameter; no significant differences were found in burger of T5 group and burger of T6 group. Also, no significant differences were found in burger samples of other dietary treatments.

Table 4: Shrinkage measurements of chicken burger

Treatments	Parameters		
	Reduction in diameter (%)	Reduction in thickness (%)	Shrinkage (%)
T1	23.30±2.65^{a}	28.51±5.70^{a}	26.64±2.80^{a}
T2	16.61±1.31^{c}	27.85±2.58^{a}	16.46±2.58^{d}
T3	14.74±1.14^{c}	21.02± 4.18^{a}	16.62±1.19^{d}
T4	16.33±1.33^{c}	24.07±5.25^{a}	17.76±0.43^{cd}
T5	19.33±1.30^{b}	23.24±6.38^{a}	20.23±1.71^{cb}
T6	19.99±0.75^{b}	29.04±0.83^{a}	21.77±2.29^{b}
SEM	0.76	2.64	1.00

$^{a-d}$ 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, 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 chicken burger processed from broiler fed on different types of vegetable oil and feed additives. Burger of T1 group had the higher shrinkage % followed by burger of T6. Slight significant differences were found between the other burger samples.

Sensory evaluation of chicken burger processed from broiler fed on different types of vegetable oil and feed additives are showed in Table 5. Burger of T6 had the higher score for appearance and slight significant differences were found in burger of T2, T4 and T5 groups. No significant differences were found between burger of T1 and T3 which had the lower score. Burger of T6 had the higher score of texture, juiciness and tenderness followed by burger of T2, T4 and T5 and no significant differences were found between the other burger samples. Burger of T6 recorded the higher score for flavour while the lower score found in burger of T1 and no significant differences were found between other burger samples. However, burger processed from T6 had the higher score of overall acceptability, while the differences between the other burger samples were slightly significant.

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Table 5: Sensory evaluation of chicken burger

Treatments	Appearance	Texture	Juiciness	Flavor	Tenderness	Overall acceptability
T1	7.00± 1.41^{b}	6.71± 1.11^{b}	6.85±1.35^{b}	6.42±1.90^{b}	6.57±1.27^{b}	6.71±1.25^{c}
T2	7.57±0.98^{ab}	7.14±1.35^{ab}	7.28±1.38^{ab}	6.71±1.80^{ab}	7.14±1.35^{ab}	7.42±0.98^{abc}
T3	7.14±1.07^{b}	6.85±0.69^{b}	6.57±1.27^{b}	6.71±1.60^{ab}	6.57±0.98^{b}	7.28±0.49^{bc}
T4	8.00±1.15^{ab}	7.28±1.60^{ab}	7.42±1.40^{ab}	7.85±0.69^{ab}	7.57±0.79^{ab}	7.71±0.76^{ab}
T5	7.71±1.11^{ab}	7.28±1.70^{ab}	7.28±1.50^{ab}	6.85±1.21^{ab}	7.14±1.68^{ab}	7.14±1.07^{bc}
T6	8.57±0.53^{a}	8.28±0.76^{a}	8.28±0.76^{a}	8.14±0.69^{a}	8.28±0.49^{a}	8.28±0.49^{a}
SEM	0.40	0.47	0.49	0.53	0.43	0.33

$^{a-c}$ 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.

4 Discussion

Addition of feed additives had no significant effects on pH value of T5 and T6 or between T2 and T4, while a slight different was found between T1 and T3. These results are close to that obtained by Zakaria et al. (2010) they found 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. These may be due to that enzymes are difficult to predict since enzyme action may be affected by many factors, including environment, amount of enzyme in the reaction, and interactions between enzyme and other substances, which are still not fully understood.

Type of dietary oil had a significant effect on cooking loss of chicken burger. These results are disagrees with that obtained by Pekel et al. (2012) they indicated that dietary fat source did not affect cooking loss of chicken meat. Although cooking loss decreased with the increasing levels of dietary fat, there were no significant differences between the dietary fat sources. The effects of feed additives on cooking loss of chicken burger were significantly different. Addition of (ZAD with palm oil and soybean oil) had no significant effect on cooking loss, while addition of (AmPhi-BACT with palm oil) caused a significant increase in cooking loss. 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. values showed significant differences in chicken burgers processed from chicken feed different types of oils and feed additives. 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 (PO) had a lower TBARS value ($P<0.05$) compared with soybean oil (SO) throughout the post-mortem storage. On the other hand, the present result disagrees with the findings of Pekel et al. (2012) they found that no significant differences were found in T.B.A. value of thigh meat from broilers

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fed diets with different levels of fat from soybean oil (SO) or neutralized sunflower soap stock (NSS).

Data of shrinkage measurements showed that dietary fat sources had significant effect on reduction in diameter and shrinkage percentages of chicken burgers. However, addition of enzymes had no significant effect on shrinkage measurements. 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.

Fat sources and addition of feed additives had no significant effects on reduction in thickness of chicken burgers. These results are close to that obtained by Dalólio et al. (2015) they 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).

Sensory evaluation of chicken burger processed from different vegetable oil and feed additives showed that the differences between sensory attributes were not significant, although the burger of T6 had the higher score in overall acceptability, but the differences between the other sensory attributes were not significant. These results are consonance with (Stanaćev et al., 2014) they found that dietary addition of vegetable oils did not show any improvement of chicken breast meat sensory quality. Also, Kalakuntla et al. (2017) concluded that sensory attributes of chicken broiler meat were not influenced due to dietary incorporation of n-3 PUFA oil sources.

5 Conclusion

The purpose of the current study was to evaluate the quality characteristics of chicken burger 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 traits of chicken burger. Further studies on the effects of feeding broiler chicken on dietary oils and commercial feed additives on the processing and quality characteristics of chicken meat products are suggested.

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