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UTILIZATION OF OKARA MEAL AS A SOURCE OF PLANT PROTEIN IN BROILER DIETS.

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ABSTRACT

This experiment was conducted to evaluate the effects of partial or complete replacement of okara meal for soybean meal on broiler performance, nutrients digestibility and economic efficiency. A total number of 350 one-day-old unsexed Ross chicks of nearly similar live body weight (45 g.) were randomly divided into equal five treatments; each contained 70 birds in seven replicates of ten birds each. Five experimental diets were formulated to be approximately iso-caloric and iso-nitrogenous according to the management recommendation guide data (Ross).

Birds were fed starter- growers (1-4 weeks) and finisher (5-7 weeks) diets *ad lib* and had free access to water for the entire experimental period. The results showed that the whole experimental period, feeding graded levels of okara meal replacing for soybean meal at levels of either 25,50 and 75 % in broiler diets had no significant effect on live body weight gain (BWG), feed conversion rate (FCR) and average live body weight (LBW) compared with control group. However, the differences were significant poorest ($P<0.05$) as replacing okara meal for soybean meal at a level of 100% compared to control group or other treatments. There were significant decreases ($P<0.05$) feed intake values due to using different levels of okara meal compared to control group. Results showed a significant increase ($P<0.05$)in average values of EE and CF digestibility and N retention with using okara meal as replacing for soybean meal at levels of 25,50 and 75% while, the use of high level (100%) significantly decreased most of nutrient digestibility coefficient and nitrogen's balance. The obtained results showed that replacing of soybean meal by okara meal at levels of 25, 50 and 75% in broiler diets had no significant effect on carcass traits of chicks, while full replacement had a significant adverse effect. The results indicated that replacing soybean meal by okara meal in broiler diets up to level of 75% can reduce cost of feeding, save a considerable amounts of expensive ingredients and prevent environmental pollution.

Keywords: Okara, broiler performance, feeding value and carcass traits.

INTRODUCTION

In the last years, there has been a tendency to avoid using ingredients of animal origin in poultry diets, to meet consumer demands for healthier food products. Thus, the search and use of plant protein sources in poultry diets are necessary. Okara , the residue left from ground soybean after extraction of water extractable fraction used to produce soymilk and tofu (Desmond,1999). About 1.1 Kg of fresh okara is produced from every kilogram of soybean processed for soymilk (Khare *et al*., 1995). In Japan, about million tons of okara were produced from the tofu production industry in 1900, most of which were burnt as waste (Ohno *et al*., 1993).

Recently in Egypt, there are some industries produce soymilk, tofu and okara as a waste products. In any country, discarding okara as waste is potentially an environmental problem because okara is highly susceptible to putrefaction. Fresh okara is not very shelf stable and it needs to be used quickly. Okara, also has a high moisture content, making it difficult to handle and too expensive to dry by conventional means (Redondo- Cuenca *et al*., 2008). Finding convenient ways to incorporate okara into feed could eliminate a possible source of pollution and add economic value to this currently valueless product (Rinaldi *et al*., 2000).There is a little information about the use of okara in poultry nutrition. Some studies were conducted by Ma *et al*. (1996), Farahat *et al*. (1998) and Abd–Elsamee *et al*. (2005) to evaluate the use of okara in poultry nutrition. They found that although okara has less protein (34 – 38%) than soybean meal (44%) but its protein quality is high for animal or poultry feeding. They found also that using okara in a balanced diet did not affect on live body weight or carcass yield.

The aim of the present experiment was to study the effect of substituting of okara for soybean meal at levels of 25, 50, 75 and 100% on broiler performance, nutrients digestibility, carcass characteristics and economic efficiency.

MATERIALS AND METHODS

Experimental system and chicks:

The present work was conducted in the poultry house in the Regional Center for Food and Feed (RCFF), Agriculture Research Center, Giza, Egypt. Three hundred and fifty one-day-old Ross broiler chicks were obtained from a commercial hatchery. Chicks were divided into five treatments of seven replicates each (10 chicks per replicate). Birds were placed in the battery cages and temperature was controlled. Feed, water and light were provided for 24 hour. Birds were vaccinated against New castle, AI and Gambaro diseases.

Diets, formulation and composition:

The experimental diets were formulated to study the effect of replacement soybean meal by product (okara) at levels of 25, 50, 75% and 100% on broiler performance, nutrients digestibility, carcass characteristics and economic efficiency.

The chemical composition of soybean meal, okara, corn gluten and yellow corn is presented in Table (1). The diets were prepared according to management recommendation guide data (Ross). Starter – grower and finisher diets were both isocaloric (3000 and 3100 kcal ME/kg diet, respectively) (Table 2). Calcium and available phosphorous were adjusted using Di-calcium phosphate and limestone. Vitamins and trace minerals were added to cover broiler's requirements. All ingredients and diets were analyzed for proximate analysis according to the AOAC (2006).The amino acid profile of soybean meal and okara meal products, except for tryptophan and tyrosine were determined according to Official methods of analysis of AOAC international 18th Eddition,2005-Current through revisional (2006).

Birds were fed the respective starter/ grower (1-4 weeks) and finisher (5-7 weeks) diets *ad lib.* and had free access to water for the entire experimental period. Body weight and feed intake were recorded at the end of starter – grower and finisher stages. Feed conversion ratio, weight gain and mortality rate percentages were calculated at the end of the trial.

Table (1): Chemical Composition of ingredients (%, on DM).

	Chemical Composition , % DM									
Ingredients	**DM**	**OM**	**CP**	**EE**	**CF**	**Ash**	**NFE**	**Ca**	**AV.P**	**ME/Kcal /Kg**
Soybean meal	91.2	94.2	43.8	1.4	7.3	5.8	41.7	0.35	0.27	2225
Corn gluten	90.7	98.2	61.9	2.5	2.1	1.8	31.7	0.09	0.25	3695
Okara	93.1	94.8	36.8	10.8	12.1	5.2	35.1	0.28	0.23	2150
Yellow corn	89.5	98.5	8.8	3.9	2.4	1.5	83.4	0.03	0.14	3320

The digestion trial:

At the end of the experiment, twelve birds from each treatment were randomly taken (two birds per replicate), weighed and allocated in metabolism cages. The collection period lasted 3 days during which feed and water were offered *ad libitum*. Feed intake was recorded accurately during the collection period. Excreta were quantitatively collected daily after spraying with 1% boric acid solution to trap the released ammonia. Feathers and any scattered feed were removed out. The collected excreta were dried in an air-draft oven at 60^{o}C for 24 hr then left in room temperature to equilibrate with atmospheric moisture. The dried excreta from each replicate for the successive 3 days collection period were pooled; finely ground, well mixed and placed in a screw-top glass jar for chemical analysis. The digestibility coefficients of nutrients and nitrogen retained of the experimental diets where feed and dried excreta were analyzed according to AOAC (2006). Nitrogen – free extracted was calculated according to Abou-Raya and Galal (1971). Fecal nitrogen was determined according to Jackobson *et al*. (1960). Digestibility coefficients were calculated. Percentages of nitrogen retention were also determined. Finally, all treatments were economically evaluated by using the net revenue per unit of total costs.

Carcass characteristics:

At the end of the experiment of period (49 days of age), the birds were starved for 12 hours then individually weighed prior to slaughter. Fourteen birds from each treatment, whose body weights were near the average value of the respective dietary treatment were selected and immediately sacrificed by decapitation to determine the carcass characteristics. The carcass with neck, giblets (liver, empty gizzard and heart) and abdominal fat were separately weighed and expressed as percent of the live body weight. The commercial carcass cuts (breast and thigh) were estimated also as a percentage of live body weight.

The data obtained were subjected to one way - analysis of variance using the linear model (GLM) of SAS (SAS institute, 1996). Means were compared using Duncan's new multiple ranges test (Duncan, 1955).

Table (2): Composition and calculated chemical analysis of tested diets during the starter/grower and finisher periods.

Items	Starter/Grower Period (1-4 weeks)					Finisher period (5-7 weeks)				
	Control	T1	T2	T3	T4	Control	T1	T2	T3	T4
Yellow corn	59.50	58.50	57.50	56.50	55.50	63.50	62.50	61.50	60.50	59.50
Soybean meal	24.00	18.00	12.00	6.00	-	24.00	18.00	12.00	6.00	-
Gluten meal	11.00	12.00	13.00	14.00	15.00	6.00	7.00	8.00	9.00	10.00
Okara meal	-	6.00	12.00	18.00	24.00	-	6.00	12.00	18.00	24.00
Vegetable oil	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00
Di-Ca-P	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
Lime stone	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Min & Vit mix*	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Colin chloride	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
L-lysine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Dl-Meth	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis										
CP %	22.94	23.02	23.18	23.33	23.35	20.11	20.34	20.45	20.57	20.61
ME Kcal / Kg	3004	3004	3003	3002	3003	3079	3079	3078	3077	3043
EE %	3.94	4.49	5.04	5.60	5.14	5.00	5.53	6.06	6.60	7.16
CF %	3.41	3.7	3.98	4.28	4.56	3.43	3.71	4.00	4.29	4.55
Ca %	1.21	1.2	1.19	1.18	1.20	1.20	1.19	1.18	1.17	1.19
AV. P%	0.48	0.47	0.46	0.45	0.46	0.48	0.47	0.47	0.46	0.46
Met %	0.58	0.59	0.60	0.60	0.62	0.59	0.58	0.59	0.59	0.60
Lys %	1.31	1.28	1.27	1.25	1.26	1.28	1.27	1.26	1.25	1.26
Met + Cys %	0.98	0.98	0.99	1.00	1.00	0.98	0.98	0.99	1.00	1.00
Price/ton (LE)	**2284**	**2180**	**2077**	**1973**	**1869**	**2112**	**2018**	**1914**	**1809**	**1706**

(*) Premix supplied per Kg of diet: Vit. (A), 12000 I. U.; Vit. (D3), 2000 I. U.; Vit. (E), 10mg; Vit. (K3), 2mg ; Vit. (B1), 1mg ; Vit. (B2), 5mg ;Vit.(B6), 1.5 mg; Vit.(B12), 10 µg; Biotin, 50ug; Pantothenic acid.,10mg;Niacin,30mg; Folic,1mg;Manganese, 60mg;zinc, 50mg; Iron,30mg; Copper,10mg;Iodine,1mg;Selenium,0.1mg and Cobalt,0.1mg (According to NRC:1994).

RESULTS AND DISCUSSION

Chemical composition of ingredients and chemical composition of the experimental diets are shown in Table (1 and 2). No variations were observed among diets in the chemical composition .Also proximate composition of okara and soybean meal.

Table (1) indicated that okara contained a high value of fat and fiber, but it had somewhat lower values of protein (36.8%) than that of soybean meal (44%). It had a lower value of soluble carbohydrate; this may be due to its solubility in water during processing of soymilk. A similar composition for okara has been reported by Nassar (2005).

Concerning mineral content okara was characterized by high level of minerals especially phosphorous, potassium, magnesium, calcium and iron. Nassar (2005) reported values of (275, 155, 423, 6 and 4.7 mg/ 100g) for Ca, Mg, P, Fe and Zn in okara, respectively.

Amino acids composition of okara:

Amino acids compositions of okara were presented in Table (3) in comparison with soybean meal. It could be noticed that okara was much poor in sulfur containing amino acids (cystine and methionine), which below than that of soybean. In this connection it could be mentioned that amino acids

pattern of okara with the exception of sulfur containing amino acids were somewhat lower than those of soybean meal, so it could be predicted that satisfactory nutritional value was obtained when added to broiler diets. Barakat (2001) stated that the limiting amino acid in soybean meal protein is methionine while the next limiting one is therionine.

Table (3): Amino acids composition of soybean meal and okara.

Amino acid	%	
	Soybean meal	Okara
Aspartic acids	5.46	3.71
Threonine	1.81	1.42
Serine	2.39	1.73
Glutamic	8.55	6.34
Proline	2.3	1.46
Glycine	1.95	1.39
Alanine	2.03	1.5
Valine	2.16	1.54
Leucine	3.58	2.58
IsoLeucine	1.99	1.44
Phynilalanine	2.43	1.66
Histidine	1.19	0.92
Lysine	2.79	1.94
Arginine	3.36	1.8
Cyctine	0.69	0.41
Methionine	0.66	0.54

Performance of chicks:

The effects of dietary treatments on broiler performance during the starter /grower period (1-4 weeks of age) are presented in Table (4). The results showed that there were significant differences ($P< 0.05$) in live body weight gain (BWG) of chicks during this period among the different dietary treatments, while birds fed okara meal at replacement rate of 25 and 50% achieved significantly higher LBW and superior BWG and attained the best feed conversion ratio (FCR) as compared to the control group and other treatments. The differences in feed intake were not significant among treatments.

There were no significant differences among LBW and BWG of broilers fed control diet or those fed graded levels of okara meal replacing for soybean meal at levels of either 25, 50 and 75% during the finisher and overall period. The poorest response was observed for broilers fed 100% okara containing diet. Similar trend was also observed in feed conversion ratio (FCR) while when fed broiler chicks diets containing 100% okara meal as replacing for soybean meal the average value of FCR was significantly ($P< 0.05$) increased compared to control and other treatments. There were significant decrease ($P<0.05$) in feed intake values due to using difference levels of okara meal as replacing for soybean meal compared to control. This may be due to the increase of crude fiber content in the diets containing difference levels of okara as replacing for soybean meal.

The obtained results were in good agreement with those reported by Farahat *et al* (1998), who found that replacement of okara meal in Pekin or Muscovy duckling diets significantly decreased feed intake compared to the control group.

Mortality rate:

The numbers of dead birds as affected by dietary treatments are presented in Table (4). Results revealed that replacing okara meal for soybean meal at levels of 25, 50 and 75% had no effect on mortality rate. While, using okara meal at 100% level of replacing soybean meal increased mortality rate. However, the post-mortem examination indicated that the death was not related to dietary treatments. These results are not in agreement with those reported by Abd-Elsamee *et al.* (2005) who found that replacing okara meal for soybean meal at levels of 20, 40, 60 and 80% increased mortality rate compared to control group.

Table (4): Effect of treatments on broiler performance.

Performance criteria	Treatments				
	Control	Okara			
		25%	50%	75%	100%
Starter/Grower period (1-4 weeks)					
IW(g/bird)	43	45	45	45	45
LBW (g/bird)	875 [b]	895 [a]	900 [a]	870 [b]	860 [b]
BWG(g/bird)	830 [b]	850 [a]	855 [a]	825 [b]	815 [b]
FI (g/bird)	1385	1375	1380	1390	1387
FCR	1.67 [a]	1.63 [b]	1.6 9 [a]	1.69 [a]	1.70 [a]
Finisher period (5-7 weeks)					
LBW(g/bird)	2150 [a]	2140 [a]	2150 [a]	2130 [a]	1950 [b]
BWG (g/bird)	1275 [a]	1245 [a]	1250 [a]	1260 [a]	1090 [b]
FI (g/bird)	2580 [a]	2500 [b]	2480 [b]	2410 [c]	2395 [c]
FCR	2.02 [b]	2.02 [b]	1.99 [b]	2.07 [b]	2.20 [a]
Overall period (1-7 weeks)					
BWG (g/bird)	2105 [a]	2095 [a]	2105 [a]	2085 [a]	1905 [b]
FI (g/bird)	3965 [a]	3875 [b]	3860 [b]	3800 [b]	3782 [b]
FCR	1.88 [b]	1.85 [b]	1.83 [b]	1.83 [b]	1.99 [a]
Mortality rate	2/70	2/70	2/70	2/70	4/70

a, b and c means with different superscript in the same row are significantly different (P<0.05).
IW= Initial weight, LBW=Live body weight, BWG=Body weight gain.
FI= Feed intake, FCR=Feed conversation ratio.

Digestion coefficients:

The digestion coefficients of nutrients for broiler chicks fed experimental diets are presented in Table (5). The results showed that there were no significant differences in digestion coefficients of DM, OM, CP, EE ,CF and nitrogen retained between control diet and containing 25,50 and 75% levels compared with that containing high level of okara meal (100%). While, there were a significant increase ($p<0.05$) in average values of CP, DM, OM and NFE with using okara meal as replacing for soybean meal at levels of 25,50 and 75% compared to 100% replacement or control. This may be due to the heating treatment of okara, which might improve the utilization of okara. The use of okara meal instead of soybean meal in broiler diets significantly ($p<0.05$) decreased almost nutrient digestibility and nitrogen

retention values with high level of substitution (100% of soybean meal). The dietary treatments had highest effect on NFE digestibility.

These results are in agreement with those obtained by Abd-Elsamee *et al*. (2005), who found a slight improvement in average values of CP,EE and nitrogen retained with using okara meal as replacing for soybean meal in broiler chick diets at a levels of 20, 40, 60 and 80%.

Table (5): Effect of treatments on digestion coefficients and nitrogen retained (%).

Digestion Coefficient,%	Treatments				
	Control	Okara			
		25%	50%	75%	100%
DM	84.6 [a]	84.9 [a]	85.1 [a]	85.3 [a]	81.3 [b]
OM	87.5 [a]	88.2 [a]	88.1 [a]	86.6 [a]	82.6 [b]
CP	87.2 [a]	89.6 [a]	90.2 [a]	89.2 [a]	86.6 [b]
EE	72.5 [b]	74.5 [a]	75.6 [a]	74.9 [a]	71.9 [b]
CF	26.6 [b]	28.8 [a]	28.9 [a]	29.1 [a]	27.3 [b]
NFE	97.2 [a]	80.3 [b]	79.3 [b]	79.9 [b]	78.7 [b]
N/ Retained	65.8 [b]	67.1 [a]	67.9 [a]	67.8 [a]	65.7 [b]

a and b means with different superscript in the same row are significantly different (P<0.05).

Carcass traits:

The results in Table (6) of carcass traits of 49-day – old broiler chicks showed that replacing of soybean meal by okara meal at levels of 25, 50 and 75% in broiler diets had no significant effect while, full replacement (100%) of soybean meal by okara meal in diets of broiler chicks had a significant adverse effect on carcass %.

The same trend was found for breast%, thigh%, gizzard %, heart %, giblets % or total edible parts of LBW. These results are in agreement with those reported by El-Nagmy *et al* .(2004) and Ibrahim (2006), who found insignificant differences in carcass yield when broiler fed on different levels of okara meal.

Table (6): Carcass characteristics of broiler chicks at 7 week of age as effected by the experimental diets.

Item	Treatments				
	Control	Okara			
		25%	50%	75%	100%
Live body weight (g/bird)	2155.00[a]	2143.18[a]	2153.09[a]	2134.51[a]	1949.10[b]
Dressing (%)	76.55[a]	76.22[a]	76.33[a]	76.40[a]	75.81[b]
Liver (%)	2.20	2.15	2.35	2.33	2.25
Gizzard (%)	1.39	1.42	1.31	1.29	1.30
Heart (%)	0.54[a]	0.57[a]	0.55[a]	0.56[a]	0.50[b]
Giblets (%)	4.13[a]	4.14[a]	4.21[a]	4.18[a]	4.05[b]
Total edible parts, %	80.68[a]	80.36[a]	80.54[a]	80.58[a]	79.86[b]
Abdominal fat,%	2.11	2.17	2.28	2.31	2.22
Breast,%	18.05[a]	18.10[a]	18.20[a]	18.07[a]	17.69[b]
Thighs,%	16.81[a]	16.66[a]	16.71[a]	16.77[a]	15.98[b]

a and b means with different superscripts in the same row are significantly different (P < 0.05).

Economic efficiency (EE):

The final body weight, length of the growing period and feeding cost generally among the most important factors involved in achievement of

maximum efficiency of meat production. The effect of treatments on economic efficiency of meat production is parented in Table (7).The economic efficiency values were calculated according to the prevailing market price of feed ingredients as well as the price of one-kilogram live body weight at the end of experimental period which was 9.5 L.E.

The obtained results showed that, there are considerable saving in feed cost/Kg live body weigh when replacing okara for soybean meal at levels of 25,50 , 75 and 100%, the highest feed cost / kg live body weigh was for control treatment (5.17LE).The decrease in cost back to that okara meal is a cheap by-product. The replacement reduced feed cost/kg diet, feed cost/kg weight gain and implored economic efficiency of feeding broiler. The net revenue and relative EE were also increased by replacing okara meal for soybean meal at level of 25, 50 and 75%. This perhaps due to lower price / ton of the diets with using okara meal as replacing for soybean meal in broiler diets.

Table (7): Effect of dietary treatments on economic efficiency (EE) of broiler chicks .

Item	Treatments				
	Control	Okara			
		25%	50%	75%	100%
Fixed cost (LE)[a]	2.50	2.50	2.50	2.50	2.50
Feed intake (g/bird):					
Starter/grower	1385	1375	1380	1390	1387
Finisher	2580	2500	2480	2410	2395
Feed cost (LE / bird):					
Starter/grower	3.16	3.00	2.87	2.74	2.59
Finisher	5.45	5.09	5.01	4.36	4.09
Feed cost / bird (LE)	8.61	8.09	7.88	7.10	6.68
Total Cost (LE)[b]	11.11	10.59	10.38	9.60	9.36
BW (kg)	2.150[a]	2.140[a]	2.150[a]	2.130[a]	1.950[b]
Cost / Kg BW (LE)	5.17	4.95	4.83	4.51	4.80
Total income (LE)[c]	20.43	20.33	20.43	19.29	18.53
Net revenue (LE)	9.32	9.74	9.60	9.69	9.17
EE[(d)]	0.84	0.89	0.93	1.01	0.98
Relative EE[(e)]	100	105	103	104	98

(a) Bird price and rearing cost. (b) Including feed cost. (c) Assuming that the selling price of one Kg live body weight is (9.5 LE). (d) Net revenue per unit total cost. (e) Considering the economic efficiency (EE) of the diet = 100%.

These results coincided with those reported by Abd-Elsamee *et al*.(2005) and Ibrahim (2006) who indicated that replacing okara meal for soybean meal at levels of 40 ,60 and 80% in broiler diets decreased the average value of total cost/ kg body weight and increased economic efficiency and relative economic efficiency value compared to the control group.

Conclusion

From the foregoing results it could be concluded that okara meal could be successfully substitute soybean meal for feeding starter/ grower chicks up to 75% level without any determination adverse effects on the broiler performance, nutrients digestibility and economic evaluation. On the light of the results it could conclude that substitution okara meal up to 75% level for

soybean meal can be recommended in formulating broiler diet in order to utilize this residue more beneficially and have a good performance with less feeding cost.

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استخدام كسب الأوكارا كمصدر للبروتين النباتى فى علائق الدواجن

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أجريت هذه الدراسة بهدف تقيم تأثير إحلال الأوكارا كأحد مخلفات التصنيع الزراعى لفول الصويا بنسب 25 ، 50 ، 75 ، 100% بدلاً من كسب الصويا فى علائق كتاكيت اللحم على الكفاءة الإنتاجية ومعاملات الهضم والكفاءة الأقتصادية. أستخدم عدد 350 كتكوت غير مجنس عمر يوم واحد من سلاله (الروص) و قسمت الطيور على خمس معاملات متساوية العدد (قسمت كل معاملة الى سبع مكررات بكل منها 10 كتاكيت). غذيت الطيورعلى عليقتين العليقة الأولى مرحلة بادى – نامى (1-4 أسابيع) تحتوى على 23% بروتين خام و 3000 كيلو كالورى طاقة ممثلة / كيلو جرام و الثانية مرحلة الناهى (5-7 أسابيع) 20% بروتين خام و3100 كيلو كالورى طاقة ممثلة / كجم. وضعت جميع الطيور تحت نفس الظروف من الرعاية والمعاملات البيطرية حتى الأسبوع السابع من العمر.

أظهرت النتائج على مدار فترة التجربة الكلية أن التغذية على مستويات متدرجة من الأوكارا لتحل محل كسب فول الصويا على مستوى 25 ، 50 ، 75 % فى علائق التجربة عدم وجود فرق معنوى على معدل الزيادة فى وزن الجسم ومعامل تحويل الغذاء أو متوسط الوزن مقارنة بعليقه المقارنة بينما يوجد انخفاض معنوى عند مستوى 0.05% فى المعاملة التى غذيت على 100% أوكارا بالمقارنة بعليقة المقارنة والمعاملات الأخرى. كما وجد إنخفاض معنوى عند مستوى 0.05% فى المتناول من الغذاء عند أستخدام مستويات مختلفة من الأوكارا مقارنة بعليقة المقارنة . كذلك أظهرت النتائج عدم وجود فرق معنوى على مستوى 0.05% فى متوسط القيمة الهضمية للمادة الجافة والمادة العضوية والبروتين الخام مقارنة بعليقة المقارنة عند مستوى 25 ،50 ، 75 % إحلال محل كسب فول الصويا بينما كان الإحلال بالمستوى (100%) له تأثير معنوى فى خفض القيم الهضمية والمحتجز من الأزوت.

أوضحت النتائج المتحصل عليها الخاصة بالذبيحة والأعضاء المختلفة لها عدم وجود فرق معنوى بمستويات الأحلال 25 ، 50 ، 75 % أوكارا محل كسب فول الصويا بينما كانت نسبة الإحلال الكامل نتائجها غير جيدة. وتبين النتائج أن إحلال كسب فول الصويا بالأوكارا حتى مستوى 75% أدى الى تخفيض تكلفة التغذية وكذلك توفير كميات من الخامات الغذائية مرتفعة السعر كسب فول الصويا كما أسهمت أيضاً فى تقليل التلوث البيئى الناتج عن عدم الأستفادة من هذه المخلفات.

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