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The use of orange Waste with and without Enzymes in broilers' diets and its effect on their performance, carcass traits and some Blood parameters

Abdel-Moneim M. A.[1*], Hamady G. A. A.[2] and Motawe H.F.A.[1]
[1]Regional Center for Food and Feed, Agriculture Research Centre, Giza, EGYPT
[2]Animal Production Department, Faculty of Agriculture, Al-Azhar University, Nasr City, Cairo, EGYPT

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Abstract

Two hundreds and eighty eight (288) ROSS chicks (one day old) were used in the present experiment. The chicks were divided into eight groups. The first two groups were a negative control group fed a basal diet and positive control group fed a basal diet supplemented with enzyme. The six remaining groups were fed diets containing orange waste in partial replacement of yellow corn at the replacement levels 20, 40 and 60% with and without enzyme supplementation. Orange waste was subjected to different chemical analysis. A digestion trial was performed to determine the gross energy of orange waste. During the experiment, the feed consumption and chicken's live body weight were recorded and the feed conversion ratio (feed/ gain) was then calculated. Blood plasma was analyzed for cholesterol and triglycerides. At the end of the 42 days of experiment the European Production Efficiency Factor (EPEF) was calculated. The results of broilers performance experiment showed that replacing the yellow corn with orange waste in broilers' diet did not cause any significant ($P<0.05$) changes in the broilers' performance at all replacement levels with and without enzyme addition except for the group fed 60% orange waste without enzyme which recorded significantly ($P<0.05$) lower numerical values of body weight, weight gain and feed intake and the worst feed conversion ratio compared to the other groups. The results of blood analysis showed that increasing the replacement level of orange waste in the diets had a positive effect causing a significant ($P<0.05$) decrease in the blood cholesterol and blood triglyceride levels of the chickens. The economic evaluation revealed that using enzyme or orange waste 20% plus enzyme increasing the European production efficiency factor (EPEF). The results of the study generally proved that the orange waste have promising application in broiler chickens' feed without any detrimental effect.

Keywords: Orange waste, broilers, performance, cholesterol, triglycerides, European production efficiency.

Introduction

In the recent years, poultry nutritionists have aimed their researches towards the use of non- traditional feed ingredients in partial or total replacement of the conventional costly ingredients. Crop residue and agro-industrial by products are being evaluated to access their nutritive potential to support poultry productivity[1]. A number of agro-industrial by-products are generated from fresh citrus after the main products of interest have been removed or extracted during processing or peeled for direct human consumption as in the case of developing countries[2].

Citrus is botanically a large family whose dominant members include sweet orange (*Citrus sinensis*), tangerine orange (*Citrus reticulata*), grape fruit (*Citrus paradisi*)[3]. The citrus production of Egypt in 2012 according to the Food and Agricultural Organization is 3461 thousand tons and the production of orange is 2350 thousand tons[4]. According to Crawshaw[5] the residue left after extraction of the juice is called citrus pulp (50–70 percent of the fruit by weight). It contains 60–65 percent peel, 30–35 percent internal tissues and up to 10 percent seeds[5].

Orange is a citrus fruit consumed in high quantities all over the world in peeled forms and as a juice. During orange juice production, great amounts of residue (peel, pulp, seeds, orange leaves and whole orange fruits that do not reach the quality requirements) are generated as waste[6]. This waste is generally available in large quantities during the citrus season and thus it may cause an environmental problem since it does not have any productive use.

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Previous studies have reported the use of different citrus wastes as feed ingredients. Oluremi *et al.*[7] reported the possibility of adding sweet orange rind in broilers diet by a level reaching 15% without any undesirable effect on growth performance. Mourao *et al.*[8] reported that the addition of citrus pulp lead to higher feed efficiency in birds fed diets containing 10 % of citrus pulp. The present work was done to evaluate the potential use of orange waste with and without enzymes in broilers' diets at its effect on performance, carcass traits and blood parameters.

Material and Methods

Test feedstuff and experimental diets preparation: Orange waste (OW) composed of peels and pulp were obtained from local Juice production factories. The peels were washed, cut into small pieces and then air dried until constant weight. The dried peels were then grinded and subjected to chemical analysis, metabolizable energy, amino acids were analyzed using a Beckman 7300 High Performance Amino Acids Analyzer (Beckman Coulter, Mannheim, Germany) and minerals were analyzed using ICP_OES optima 2000 (Perkin Elmer). A representative sample of the dried orange waste was taken and divided to three portions. The enzyme used in this study was "ALLZYME^{TM} SSF" obtained from ALLTECH co. USA. Each 1000g of the enzyme contain (Phytase 300 SPU/g, Protease 700 HTU/g, Cellulase 40 CMCU/g, Xylanase 100XU/g, Beta glucanase 200 BGU/g, Amylase 30 FAU/g and pectinase 4000 AJDU/g).

Experimental design and diets formulation: Two hundreds and eighty eight (288) ROSS chicks (one day old) were used in the experiment. The experiment was divided into 3 treatments with replacement levels of 20, 40 and 60% orange waste (in partial replacement of yellow corn). Each treatment consisted of three replicates. The experimental groups were arranged as follows: Group 1: negative control (Control without Enzyme), Group 2: positive control (Control + Enzyme), Group 3: 20% orange waste without Enzyme, Group 4: 40% orange waste without Enzyme, Group 5: 60% orange waste without Enzyme, Group 6: 20% orange waste + Enzyme, Group 7: 40% orange waste + Enzyme, Group 8: 60% orange waste + Enzyme

The experimental diets were formulated according to the NRC [9] recommendations to meet the nutrient requirements of broilers from day 1 to 28 (starter diet) and from day 29 to 42 (finisher diet). The starter diets contained 23% CP and 3000 kcal ME/Kg and the finisher diet contained 20% CP and 3200 kcal ME/Kg.

Tables 1 and 2 show the formulation and nutrients composition of the experimental and control diets used at the starter and finisher periods.

Table-1
Starter diets composition and analysis

Ingredients	Control (negative	OW 20%	OW 40%	OW 60%	Control (positive)	OW 20% +E	OW 40% +E	OW 60% +E
Corn 7.5%	56.460	45.170	33.870	22.580	56.420	45.130	33.830	22.540
Soybean (46%)	28.500	28.830	30.530	33.000	28.500	28.830	30.530	33.000
Gluten (60%)	8.310	8.310	7.310	5.440	8.310	8.310	7.310	5.440
OW	-	11.293	22.586	33.879	-	11.293	22.586	33.879
Enzyme	-	-	-	-	0.040	0.040	0.040	0.040
Oil	2.700	2.100	1.500	0.900	2.700	2.100	1.500	0.900
Di-Calcium phosphate (24.5%)	2.030	2.030	2.030	2.030	2.030	2.030	2.030	2.030
Limestone (39.8%)	0.575	0.842	0.749	0.746	0.575	0.842	0.749	0.746
Vitamin	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
Salt	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
Choline (70%)	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
Dl-Methionine	0.190	0.190	0.190	0.190	0.190	0.190	0.190	0.190
L-Lysine	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460
Total	100	100	100	100	100	100	100	100
Determined analysis (%)								
Crude protein	23.10	23.30	23.00	23.40	23.30	23.00	23.10	23.30
Calcium	1.00	1.13	1.14	1.10	1.11	1.12	1.12	1.11
Total phosphorus	0.77	0.75	0.77	0.76	0.77	0.75	0.77	0.76
Ether extract	2.90	3.10	3.20	3.00	3.00	2.95	2.90	3.30
Ash	6.20	6.00	5.90	6.40	6.40	6.10	6.30	6.00
Crude fiber	2.50	3.81	4.70	2.58	2.58	3.91	4.61	5.20

(*)Premix supplied per Kg of diet: Vit. (A), 12000 I.U., Vit.(D_3), 2000I.U. ; Vit.(E), 10mg ;Vit.(K_3) , 2mg; Vit.(B_1), 1 mg; Vit.(B_2), 5 mg; Vit.(B_6), 1.5 mg; Vit.(B_{12}), 10 ug; Biotin, 50ug; Choline chloride,500mg; Pantothenic acid , 10 mg; 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).

Table-2
Finisher diets composition and analysis

Ingredients	**Control (negative)**	**OW 20%**	**OW 40%**	**OW 60%**	**Control (positive)**	**OW 20% +E**	**OW 40% +E**	**OW 60% +E**
Corn 7.5%	62.500	50.000	37.500	25.000	62.460	49.960	37.460	24.960
Soybean (46%)	24.000	24.300	25.500	28.500	24.000	24.300	25.500	28.500
Gluten (60%)	6.300	6.305	6.000	4.000	6.305	6.305	6.000	4.000
OW	-	12.500	25.000	37.500	-	12.500	25.000	37.500
Enzyme	-	-	-	-	0.040	0.040	0.040	0.040
Oil	3.600	3.300	2.400	1.400	3.600	3.300	2.400	1.400
Di-Calcium phosphate (24.5%)	1.825	1.820	1.825	1.825	1.820	1.820	1.825	1.825
Limestone (39.8%)	0.490	0.490	0.490	0.490	0.490	0.490	0.490	0.490
Vitamin	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
Salt	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
Choline (70%)	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
Dl-Methionine	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170
L-Lysine	0.340	0.340	0.340	0.340	0.340	0.340	0.340	0.340
Total	100	100	100	100	100	100	100	100
Determined analysis (%)								
Crude protein	20.20	20.30	20.00	20.10	20.00	20.40	20.10	20.00
Calcium	0.89	0.90	0.91	0.88	0.90	0.89	0.88	0.89
Total phosphorus	0.68	0.67	0.68	0.69	0.67	0.68	0.68	0.69
Ether extract	3.60	3.20	3.30	3.10	3.40	3.10	3.10	3.40
Ash	5.80	6.30	6.60	6.60	5.90	6.40	6.40	6.30
Crude fiber	2.55	3.45	5.10	4.60	2.60	3.71	4.80	5.35

*Premix supplied per Kg of diet: Vit. (A), 12000 I.U., Vit.(D_3), 2000I.U. ; Vit.(E), 10mg ;Vit.(K_3) , 2mg; Vit.(B_1), 1 mg; Vit.(B_2), 5 mg; Vit.(B_6), 1.5 mg; Vit.(B_{12}), 10 ug; Biotin, 50ug; Choline chloride,500mg; Pantothenic acid , 10 mg; 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)

Every dietary treatment was fed to 3 replicates of 12 chicks each. The average initial live body weights of all replicates were nearly the same at the start of the experiment. Electric heaters were used to keep the required temperature for the brooding period. Light was provided 24 hr daily throughout the experiment. Feed and water were provided *ad-libitum* throughout the 42 days experimental period.

Digestibility trial: A digestion trial was performed using 15 male broiler chicks from 45 to 52 days of age. It consisted of 4 days of adaptation, followed by 72 h with to feed from each treatment. Fifteen birds (3 Replicates per each diet) were housed in individual cages with wire bottoms. Birds had free access to water throughout the experiment. Excreta were collected for each 24-hour period for days 50, 51 and 52. Any contaminants or feathers were carefully removed, and the excreta were stored in containers at –25°C. Excreta samples were subsequently dried in an oven at 80°C, weighed, ground through a 0.5 mm sieve, and stored in an airlock plastic vessel at 4°C until analysis. A sample of the orange waste (OW) and excreta were analyzed to determine gross energy by using the (Parr 1261 Bomb Calorimeter).

The true metabolizable energy (TME) was then calculated according to the following equation[10]:

$$\mathrm{TME}\ (\mathrm{Kcal/g}) = [(\mathrm{GE_f} * \mathrm{X}) - (\mathrm{Y_{ef}} - \mathrm{Y_{ec}})]/\mathrm{X}$$

Where; GE_f is the gross energy of 1g of test material, X is the amount of test material force fed, Y_{ef} is the gross energy of the excreta of the fed birds, Y_{ec} is the gross energy of the excreta of the control unfed birds.

Chickens performance and carcass traits determination: Feed consumption and chicken's live body weight were recorded at 14th, 28th and 42th day after fasting overnight and feed conversion ratio (feed/ gain) was then calculated. During the experimental period, mortality rate and signs of any apparent health problems were recorded. At the end of the experimental period (6 weeks of age), a slaughter test for carcass traits was performed on 48 birds including 6 from each of the control groups and 6 birds from each experimental replicate. After the removal of head, viscera, shanks, spleen, gizzard, heart and liver the rest of the body was weighted to determine the dressed weight. The edible organs (heart, empty gizzard and liver) were then individually weighed. All weights were recorded to the nearest 0.01 g and expressed as percentage of fasted weight.

Chemical and blood Analyses: Moisture, CP, crude fiber, and ash were analyzed according to the methods of the Association of Official Analytical Chemists International[11]. Ether extract was determined by extraction in petroleum ether following acidification with 4 N HCl solution[12]. Blood plasma was analyzed for cholesterol and triglycerides using kits purchased from the agent of DiaSys Diagnostic System GmbH.

Economics of production: At the end of the experimental period (42 days) the European Efficiency Factor (EEF) was calculated, based on the age of broilers at sacrifices (days), their average live weight (kg/head), viability (%) and feed conversion ratio (FCR) (kg feed/kg gain). European Production Efficiency Factors (EPEF) is given by the following equation[13]

$$\mathrm{EPEF} = 100 * [\mathrm{BW\ (Kg)} * \mathrm{viability\ (\%)}]/[\mathrm{Age\ (days)} * \mathrm{FCR}]$$

Statistical Analysis: Data were statistically analyzed using the general linear model for analysis of variance of SAS[14] and the test of significance for the difference between means was computed using Duncan's[15] multiple range tests.

Results and Discussion

The chemical composition, amino acids and minerals content of orange waste are summarized in table-3. The results of proximate composition of orange waste showed that it contains adequate amounts of nutrients that allow it to be used in broiler diets.

The results of broilers performance experiment parameters are shown in table-4. It can be observed that replacing the yellow corn with orange waste in broilers' diet did not cause any significant (P<0.05) changes in the broilers' live body weight, weight gain and feed intake at all replacement levels with and without enzyme addition. It is also worth noting that although there are no significant (P<0.05) differences but the group fed 60% orange waste without enzyme showed lower numerical values of body weight, weight gain and feed intake when compared to all other experimental groups. No significant (P<0.05) differences were also noted for the feed conversion ratio of all experimental groups and the control groups; except for the group fed 60% orange waste without enzyme which recorded the significantly (P<0.05) worst ratio compared to the control groups.

The decline in body weight, weight gain, feed intake and feed conversion ratio for group fed 60 % orange waste without enzyme, may be due to remaining anti-nutritional substances (such as oxalate, saponins, tannins, phytates) in peels. In addition, the high crude fiber level in the orange peel leading to decreasing in ration palatability thus the lower feed intake. These results are in agreement with the findings of Oluremi *et al.*[7] reported that sweet orange rind could replace maize in broilers diet of up to 15 % level without any undesirable effect on performance.

Table-3
Orange waste analysis results

Analysis	
Amino acids(%)	
Argenine	6.41
Aspartic acid	13.21
Alanine	3.44
Isoleucine	2.19
Proline	11.88
Therionine	2.03
Glutamic acid	6.56
Glycine	3.28
Serine	2.97
Cysteine	1.56
Valine	3.44
Phenylalanine	3.91
Lysine	3.13
Leucine	3.91
Methionine	0.94
Histidine	1.72
Tyrosine	2.81
Chemical analysis(%)	
Dry matter	91.27
Organic matter	96.85
Crude protein	6.40
Crude fiber	8.67
Fat	2.51
Ash	3.15
Moisture	8.73
Metabolizable energy (Kcal/Kg)	3419
Minerals(mg/Kg)	
Calcium	6825
Magnesium	808.3
Phosphorus	968.2
Copper	2.442
Iron	77.98
Manganese	3.88
Sodium	383.6
Zinc	22.20

Regarding the carcass characteristics given in table-5, it can be noticed that there are no significant (P<0.05) differences in live body weight, gizzard and heart weights for all the experimental groups. The groups fed different levels of orange waste with or without enzyme supplementation recorded a significant decrease in their edible parts weight as compared to the control groups. For the dressed weight there were no significant differences between the groups fed orange waste with and without enzyme and their respective control groups except for the group fed 60% orange waste with enzyme which showed lower dressed weight compared to the positive control group. The groups fed different levels of orange waste with or without enzyme supplementation recorded a significant decrease in their liver weight as compared to the negative control group; whereas no significant difference were reported between all treated groups compared to the positive control group.

Table -4
Effect of different treatments on broilers' performance (Means ± S.E)

Treatment	Average body weight (g)	Body weight gain (g)	Feed intake (g)	Feed conversion ratio
Control (-)	2269.00^{ab} ±63.17	2225.00^{a}±63.17	3735.00^{a}±25.70	1.68^{b}±0.04
Control (+)	2281.00^{a}±50.71	2237.00^{a}±50.71	3746.67^{a}±1715	1.67^{b}±0.03
OW 20%	2247.00^{ab}±45.54	2203.00^{a}±45.53	3781.00^{a}±48.13	1.71^{ab}±0.04
OW 40%	2197.33^{ab}±136.5	2153.33^{ab}±136.5	3731.00^{a}±70.66	1.73^{ab}±0.07
OW 60%	2114.67^{b}±64.34	2070.67^{b}±64.34	3671.33^{a}±76.69	1.77^{a}±0.02
OW 20% +E	2278.00^{ab}±8.72	2234.00^{a}±8.71	3748.00^{a}±30.19	1.67^{b}±0.02
OW 40% +E	2241.00^{ab}±42.57	2197.00^{a}±42.57	3711.67^{a}±99.40	1.68^{b}±0.01
OW 60% +E	2180.33^{ab}±53.25	2136.33^{ab}±53.25	3723.33^{a}±51.31	1.72^{ab}±0.04

^{a,b} Means the same column have the different superscript are significantly different (P<0.05). S.E: Meaning standard error.

Table-5
Effect of different treatments on broilers' carcass (Means ± S. E)

Treatment	Body Weight	Edible parts	Dressing weight	Liver	Gizzard	Heart
Control (-)	2229.33^{a}±9.07	87.91^{a}±0.50	82.45^{ab}±0.16	2.28^{a}±0.41	2.70^{a}±0.41	0.47^{a}±0.09
Control (+)	2240.00^{a}±9.53	87.89^{a}±0.55	82.56^{a}±0.30	2.15^{ab}±0.29	2.69^{a}±0.07	0.49^{a}±0.08
OW 20%	2239.33^{a}±39.52	87.09^{b}±0.15	82.28^{ab}±0.42	1.74^{b}±0.07	2.57^{a}±0.25	0.50^{a}±0.03
OW 40%	2204.00^{a}±16.82	87.09^{b}±0.07	81.98^{ab}±0.13	1.87^{b}±0.13	2.73^{a}±0.05	0.51^{a}±0.06
OW 60%	2169.33^{a}±74.78	86.82^{b}±0.21	81.66^{b}±0.54	1.87^{b}±0.18	2.80^{a}±0.20	0.49^{a}±0.04
OW 20% +E	2239.33^{a}±39.52	86.86^{b}±0.55	82.04^{ab}±0.80	1.74^{b}±0.07	2.57^{a}±0.25	0.50^{a}±0.03
OW 40% +E	2222.33^{a}±48.33	87.09^{b}±0.07	81.98^{ab}±0.13	1.87^{b}±0.13	2.73^{a}±0.05	0.51^{a}±0.06
OW 60% + E	2169.33^{a}±74.78	86.82^{b}±0.21	81.66^{b}±0.54	1.87^{b}±0.17	2.80^{a}±0.20	0.49^{a}±0.04

^{a,b} Means the same column have the different superscript are significantly different (P<0.05). S.E: Meaning standard error.

The results of blood parameters table-6 showed that increasing the replacement level of orange waste in the diets resulted in a significant decrease in the blood cholesterol and blood triglyceride levels of the chickens. These results may be due to that, orange wastes contain properties of hesperidin that used to reduce cholesterol and triglyceride levels in the blood[16]. These results are matched with the finding of Trovato et al.[17] and Parmar and Kar[18], they found that sweet orange and other citrus are also efficient in lowering blood cholesterol levels.

The statistical evaluation of results in table-7 indicated that the (EPEF) were increased significantly for the control group (+) and (OW20%+E) followed in a significant (P≤0.05) decreasing order by control group (-), (OW40%+E), (OW20%) , (OW40%) , (OW60%+E) and (OW60%) respectively.

Table-6
Effect of different treatments on broilers' blood (Means ± S.E)

Treatment	Cholesterol	Triglyceride
Control (-)	189.33^{a}±7.37	117.00^{a}±2.00
Control (+)	188.67^{a}±1.52	113.33^{ab}±1.52
OW 20%	183.33^{ab}±3.05	110.67^{b}±2.51
OW 40%	176.67^{c}±2.51	104.00^{c}±4.58
OW 60%	168.00^{d}±2.64	97.00^{d}±2.00
OW 20% +E	183.00^{abc}±4.00	110.67^{b}±2.30
OW 40% +E	177.33^{bc}±1.15	105.00^{c}±2.00
OW 60% +E	166.33^{d}±1.15	92.33^{e}±2.08

$^{a, b,c,d,e}$ Means the same column have the different superscript are significantly different (P<0.05). S.E: Meaning standard error.

Table-7
Effect of different treatments on (EPEF*) (Means ± S. E)

Treatment	Live weight (g)	Feed conversion ratio	Livability (%)	EPEF
Control (-)	2269.00^{ab} ±63.17	1.68^{b}±0.04	100	321.57 ^{b} ±0.33
Control (+)	2281.00^{a}±50.71	1.67^{b}±0.03	100	325.20 ^{a} ± 0.67
OW 20%	2247.00^{ab}±45.54	1.71^{ab}±0.04	100	312.86 ^{d} ± 0.68
OW 40%	2197.33^{ab}±136.5	1.73^{ab}±0.07	100	302.36 ^{e} ± 0.66
OW 60%	2114.67^{b}±64.34	1.77^{a}±0.02	97.23	276.49 ^{g} ± 0.66
OW 20% +E	2278.00^{ab}±8.72	1.67^{b}±0.02	100	324.77 ^{a} ± 0.67
OW 40% +E	2241.00^{ab}±42.57	1.68^{b}±0.01	100	317.60 ^{c} ± 0.67
OW 60% +E	2180.33^{ab}±53.25	1.72^{ab}±0.04	97.23	293.41 ^{f} ± 0.65

*European production efficiency factor. ^{a,b,c,d,e} Means the same column have the different superscript are significantly different (P<0.05). S.E: Meaning standard error.

Conclusion

This study showed that inclusion of orange waste in diets for broilers had potential. The inclusion of orange waste levels in the diets was not detrimental to growth performance, carcass characteristics and haematological parameters. In conclusion results of the study confirmed the orange waste have promising application in broiler chickens' feed.

Reference

1. Oluremi O.I.A., Ngi J. and Andrew I.A., Phytonutrients in citrus fruit peel meal and nutritional implication for livestock production, *Livestock Research for Rural Development,* **19(7)** **(2007)**

2. Oluremi O.I.A ., Andrew I.A. and Ngi J., Evaluation of nutritive polential of the peels of some citrus fruit varieties as feeding stuffs in livestock production., *Pak. J. Nutr.,* **6**, 653-656 **(2007)**

3. Ojighen V.O., Ejembi E.H. and State B., The Nutritive Potentials of Sweet Orange (*Citrus sinensis*) Rind in Broiler Production, *Int. J. Poult. Sci,* **5(7)**, 613–617**(2006)**

4. FAO (2004), FAOSTAT data 2005. Food and Agricultural Organisation of the United Nations, 00100, Rome, Italy, **(2005)**

5. Crawshaw R., Co-product Feeds: Animal Feeds from the Food and Drinks Industries, Nothingham University Press, **(2004)**

6. Rezzadori K., Benedetti S. and Amante E.R., Proposals for the residues recovery: Orange waste as raw material for new products, *Food and Bioproducts Processing,* **90(4)**, 606–614 **(2012)**

7. Oluremi O.I.A., Ojighen V.O. and Ejembi E.H., The nutritive potentials of sweet orange (Citrus sinensis) rind in broiler production, *Int. J. Poult. Sci.,* **5,** 613-617 **(2006)**

8. Mourão J. L., Pinheiro V.M., Prates J.M., Bessa R.J.B., Ferreira L.M., Fontes C.M.G. and Ponte P.I.P., Effect of dietary dehydrated pasture and citrus pulp on the performance and meat quality of broiler chickens, *Poult. Sci.,* **87(4)**, 733–43 **(2008)**.

9. NRC, Nutrient requirements of poultry, Ninth Revised Edition, National Academy Press, Washington D.C., **(1994)**

10. Sibbald I.R., A bioassay for true metabolism energy in feeding stuffs, *Poult. Sci.,* **55**, 303–308 **(1976)**

11. AOAC., Official Methods of analysis of AOAC International, 19th Edition., **(2012)**

12. Wiseman J., Villamide M.J., Carabaño M.J., Carabaño R., Prediction of the digestible energy and digestibility of gross energy of feeds for rabbits. 1. Individual classes of feeds., *Anim. Feed Sci. Technol.,* **39**, 27-38 **(1992)**

13. Broiler Management Manual Ross-308, Home page address: www.aviagen.com, 1-114., **(2009)**

14. SAS Institute., SAS User's Guide : Statics, Release 9.1. SAS Institute Inc., Cary, NC, **(2004)**

15. Duncan D.B. Multiple range and multiple F-tests, Biometrics **11**, 1-42 **(1955)**

16. Vinson J.A., Liang X., Proch J., Hontz B.A., Dancel J. and Sandone N., Polyphenol antioxidants in citrus juices: in vitro and in vivo studies relevant to heart disease, *Advances in experimental medicine and biology,* **505,** 113-122 **(2002)**.

17. Trovato A., Monforte M.T., Barbera R., Rossitto, Galati A.E.M. and Forestieri A.M., Effects of fruit juices of Citrus sinensis L. and Citrus limon L. on experimental hypercholesterolemia in the rat, *Phytomed.,* **2**, 221-227 **(1996)**

18. Parmar H.S., Kar A., Antiperoxidative, Antithyroidal, Antihyperglycemic and Cardioprotective Role of Citrus sinensis Peel Extract in Male Mice, *Phytother Res,* **22**, 791-795 **(2008)**