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INFLUENCE OF INCREASING FEEDING LEVELS OF CORN DISTILLERS DRIED GRAINS WITH SOLUBLES (DDGS) TO GROWING RABBITS ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS AND FATTY ACIDS PROFILE OF MEAT

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SUMMARY

Thirty six white New Zealand growing male rabbits 6 weeks old were used to investigate the influence of feeding increasing levels of DDGS on performance, carcass quality and meat fatty acids profile. Rabbits were allotted into 4 treatment groups of 9 rabbits each, and fed one of the experimental diets which contain 0, 10, 20 and 30 % dried distillers corn grains with solubles (DDGS) for 12 weeks after which 3 rabbits of each group were used to test coefficients of total tract apparent digestibility of the experimental diets. At the end of the experimental period, 3 rabbits of each group were slaughtered to determine carcass quality and fatty acids profile. Inclusion of graded levels of DDGS decreased feed intake and improved feed conversion. Coefficients of total tract apparent digestibility showed no difference between treatments for DM, OM, CP. However, EE digestion coefficients of the diets used increased by increasing DDGS level and the values of CF were inconsistent. Carcass weight and dressing percentage were slightly increased by increasing the level of DDGS. Carcass fat content significantly increased by increasing DDGS level. Fatty acids profile showed slight variations among treatments with remarkable increase, yet insignificant, in PUFA by adding increasing levels of DDGS.

Keywords: Rabbit, DDGS, fatty acids, carcass quality, performance

INTRODUCTION

A remarkable sector of consumers consider rabbit meat as a healthy source of animal proteins due to its low content of fat and its content of several bioactive compounds (DalleZotte and Szendro, 2011). Rabbit digestive physiology allows the consumption of fibrous feeds and converting about 20% of it into protein (DalleZotte, 2014). Total rabbit meat production worldwide was estimated as 1.4 million tons of rabbit meat out of which 72, 83% from Asia, 19.40% from Europe and 7.77 % from Africa and Americas. Egypt produces around 65602 tons/year of rabbit meat (FAOSTAT, 2018).

The rabbit industry depends mainly on soybean meal as main source of plant protein in feeding rabbits. The consistency of nutrients content of soybean meal and other plant protein sources allowed its use safely based on the published data of its nutrients content (Volek *et al*., 2018).

However, prices of soybean meal are escalating periodically worldwide and hence, searching for an alternative plant protein sources to substitute soybean meal is needed.

Distillers Dried Corn Grains with solubles (DDGS) is a product originated from the corn-based fuel ethanol industry and being used as an ingredient in animal feeds, to replace partially other plant protein sources with a competitive price. During the distillation process carbohydrate content of the corn grain are converted into ethanol, other nutrients are concentrated (protein, fiber and lipids). Variation of DDGS fat content is a concern. DDGS contains 7 to 15% fat with 70 to 80% of mono- and poly-unsaturated fatty acids (Alagón *et al*., 2015). Values reported varied widely (10% NRC, 2001; 10.9% FEDNA, 2003 and 4.4% INRA, 2004). This variation is due to the amount of condensed distillers solubles added back to the non-fermented wet cake to produce DDGS (Noll *et al*., 2007).

The fat of DDGS is mainly unsaturated fatty acids with abundance in linoleic (C18:2) and oleic (C18:1) as reported by Moreau *et al*. (2012).

Using DDGS as a plant protein source in rabbit diets could have an effect on the content of the produced meat and may also affect the quality of the carcass in the retail stores due to its content of fat. This work aimed to investigate the effect of feeding different levels of DDGS in complete feeds on growth performance, carcass characteristics and fatty acids profile in the meat of growing rabbits.

MATERIALS AND METHODS

This study was carried out at the rabbit research unit, Nubaria experimental farm affiliated to the Animal Production Department, National research Centre. The room temperature during the experimental period averaged between 16-18 °C with 65% average relative humidity.

Experimental diets:

The experimental diets were formulated to include either 0, 10, 20 or 30% of distillers dried grains with solubles (DDGS) replacing mainly a portion of soybean meal and corn (Table 1).

Table 1. Composition and calculated analysis of the experimental diets

Ingredients	Control	10% DDGS	20% DDGS	30% DDGS
Yellow corn	9.70	4.10	3.00	4.00
Soybean meal (44%)	16.20	10.90	5.70	0.80
Barley	20.10	23.10	19.75	13.30
Wheat bran	15.50	17.30	17.00	15.50
Choline chloride (50%)	0.10	0.10	0.10	0.10
Clover hay	33.9	30.0	30.0	32.0
DDGS	--	10	20	30
DL-methionine	0.255	0.20	0.17	0.14
L-Lysine HCl	--	0.10	0.28	0.37
Di-calcium phosphate	0.08	--	--	--
Limestone	0.57	0.68	0.61	0.49
Salt	0.295	0.220	0.090	--
Molasses	3.00	3.00	3.00	3.00
Vit. & Min. mixture*	0.30	0.30	0.30	0.30
Chemical composition**				
Crude protein	16.5	16.5	16.5	16.5
DE (Kcal/kg)	2620	2619	2620	2620
Ether extract%	2.41	3.00	3.65	4.31
Crude fiber%	14.54	14.74	15.60	16.79
Calcium%	0.82	0.82	0.82	0.82
Total phosphorus%	0.50	0.53	0.55	0.55
Methionine%	0.44	0.40	0.38	0.35
Methionine + Cystine%	0.65	0.63	0.62	0.61
Lysine%	0.66	0.66	0.68	0.65
Sodium%	0.23	0.24	0.24	0.25

*Vitamins & Minerals mixture supplied per kg of diet: Vit. A, 10000 IU; Vit.D_3, 900 IU; Vit.E, 50 mg; Vit.K, 2 mg; Vit.B1, 2 mg; Vit.B2, 4 mg; Vit.B6, 2 mg; Vit. B12, 10 µg; Niacin, 50 mg; Pantothenic acid, 10 mg; Folic acid, 3 mg; Biotin, 100 µg; Copper, 30 mg; Iodine, 0.5 mg; Iron, 50 mg; Manganese, 50 mg; Zinc, 50 mg; Cobalt, 0.1 mg and Selenium, 0.2 mg. **Calculated according to tables of CLFF (2001).

The experimental diets were formulated to have similar levels of crude protein (CP) and digestible energy (DE) and met the nutrients recommendation of New Zealand white rabbits. The DDGS included in the diets were imported from USA by a local supplier ,from whom we purchase the DDGS needed for this experiment, before being included in the diets, representative sample was analyzed for the content of dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF) and ash content (Table 2). All the diets were pelleted with a diameter 3 mm, dried and stored in darkness. No medication was added to either feed or water; the experimental rabbits had free access to clean drinking water.

Table 2. Chemical composition of DDGS

Item	Moisture %	CP %	CF %	EE %	NFE %	Ash %
DDGS	6.40	25.2	7.6	16.6	38	6.20

Animals and experimental design:

A total number of 36 New Zealand white (NZW) rabbits at 6 weeks of age were divided into 4 groups with 3 replicates per group and 3 rabbits in replicate and the rabbits were fed one of the 4 diets until slaughtering at 12 weeks of age. Feed intake was recorded and total fat intake was calculated during all fattening period.

Coefficient of total tract apparent digestibility (CTTAD):

Twelve male New Zealand white rabbits (three per treatment) of each group of about 12 weeks of age were used to determine digestion coefficients of the experimental diets. Three rabbits of each treatment approximately similar in live body weight were housed individually in equipped cages which facilitate collection of feces. Feed intake was daily recorded, the collection period lasted for 5 days in which feces were daily collected at fixed time in the morning, sprayed with 2% boric acid dried at 60°C for 48 hours in air drying oven. The feces were then finely ground and mixed to ensure sample uniformity and then stored in screw top glass jar for the chemical analysis. Coefficients of total tract apparent digestibility of experimental diets were determined for DM, OM, CP, EE, CF and NFE (Villamide *et al*., 1989).

***Carcass measurements**:*

At 12 weeks of age after overnight fasting all rabbits were transported to slaughter house and then individually weighed (pre-slaughter weight) and slaughtered by cutting the carotid arteries and jugular veins, slaughtering and carcass dissection were performed according to the recommendations of the

World Rabbit Science Association (Blasco and Ouhayoun, 1993). The slaughtered rabbits were bled and body weight was recorded after complete bleeding. Carcass was eviscerated after skinning.

The carcass was divided into fore, middle and hind parts by cutting between the last thoracic and the first lumber vertebra (Blasco and Ouhayoun, 1993). The carcass was weighed and the weights of the fore part, middle partand hind part were weighed and expressed as a percentage of carcass weight (CW).

The eye muscles (*longissimus dorsi*) were removed and collected 24 h postmortem from the carcass and immediately frozen at −20°C until analyzed.

Sampling, analysis and fatty acid profile:

The proximate composition of diets and meat were determined according to the AOAC procedures (AOAC, 2000). The meat and diet samples were analyzed to determine dry matter, total N content, ash and ether extract (EE) using the Soxhlet method. Gross energy (GE) by means of an adiabatic bomb calorimeter (IKA C7000,Staufen, Germany).To determine the fatty acids profile of the meat, samples of about 5 g were extracted in a homogenizer with 20 ml of 2:1 chloroform-methanol and then filtered through Whatman No.1 filter paper.

Fatty acids were determined as methyl esters (FAME) with a varian cp.3800 Gas chromatography apparatus. Saturated, mono and polyunsaturated fatty acids of meat were expressed as percentage of fat content.

Statistical analysis:

Data were statistically analyzed by one-way analysis of variance for treatment effect, using the general linear model (GLM) procedure of SAS (1990). When the model was significant, Duncan's new multiple range test was used to separate treatment means (Duncan, 1955). Differences between treatment means were considered significant at (P<0.05).

RESULTS AND DISSCUSSION

Initial and final body weight (BW), total feed intake (FI), total fat intake and feed conversion ratio (FCR) are presented in Table (3). The average feed intake showed significant (P<0.05) decrease among treatment groups and the control group. However the final body weight showed no significant differences among treatments and control group. On the other hand the total fat intake increased obviously by increasing DDGS percentage in the diet. This increase in total fat intake was equivalent to 15.14 gm (17%) for group fed 10% DDGS, 36.92 gm (41.53%) for group fed 20% DDGS and 58.76 (66.08%) for group fed 30% DDGS. The increase of total fat intake by increased DDGS in the diets may be resulted in a decrease of total feed intake (Table 3). Feed conversion ratio improved significantly (P<0.05) by increased DDGS percentage to reach (1.89) in treatment group fed 30% DDGS compared to control group (2.09). Feed conversion ratio of the growing rabbit can be used as a parameter to improve production performance. Xiccato (2010) revealed that feed conversion ratio of the growing rabbits improve with the concentration in digestible energy of the feed. Increasing DE level by 1 MJ DE/ Kg decreases feed intake by about 10% and FCR by 0.29 point.

Table 3. Effect of experimental treatments on performance and total fat intake

Parameters	Control	10% DDGS	20% DDGS	30% DDGS	LSM
Initial body weight, g	692	705	711	708	8.34
Final body weight, g	2456	2470	2488	2518	23.22
FI (g/rabbit)	3689^{a}	3468^{b}	3447^{b}	3426^{b}	38.81
% fat in diet	2.41	3.00	3.65	4.31	-----
Total fat intake (g/rabbit)	88.90	104.04	125.82	147.66	-----
FCR	2.09^{a}	1.97^{b}	1.94^{c}	1.89^{d}	0.01

^{a,b} values in the same row within section with different superscripts differ (p<0.05).
FI: feed intake, FCR: feed conversion ratio.

Maertens, (2009) found that lower feed intake and higher feed efficiency means lower nutrient excretion as manure, which is important for environment and farm management.

Rabbit regulate feed intake to meet the energy requirements (Falcao *et al*., 2000 and Fernandez *et al*., 2000). It seems that the high fat intake due to the inclusion of high percentage of DDGS (rich in EE%) improved feed conversion ratio, however, body weight was not affected by the increased level of DDGS. The results of this study agreed with those obtained by (Chen, 2008). Furthermore, Alhaidary *et al*. (2010) reported that feed conversion ratio improved with the increasing of fat intake levels in rabbits.

Coefficients of total tract apparent digestibility (CTTAD):

The CTTAD of dry matter (DM), organic matter (OM) and crude protein (CP) of the experimental diets, are slightly different from the control treatment that was fed 0% DDGS (Table 4). The results of this work agrees with the findings of Fernandiz *et al*. (1994) and Pascual *et al*. (1998) who reported slight increase in protein digestibility values by increased level of EE in the rabbit diets. De Blas *et al*. (1995) found no differences in protein digestibility associated with increased level of EE, which lend support to the results of this study.

Table 4. Coefficients of total tract apparent digestibility of experimental diets

Parameters	Control	10% DDGS	20% DDGS	30% DDGS
DM	71.59	72.10	67.86	72.56
OM	73.78	73.71	70.02	73.91
CP	71.73	72.24	68.45	74.10
EE	64.92	59.43	70.30	79.42
CF	47.50	49.05	44.88	56.11
NFE	82.58	80.24	77.26	79.94

DM= Dry matter, OM =Organic matter, CP = Crude protein, EE = Ether extract, CF = Crude fiber and NFE= Nitrogen free extract

The results of CTTAD of ether extract (EE) showed a remarkable increase (14.5%) in the treatment group fed 30 % DDGS compared with control treatment group, these results agreed with Uhlfrova *et al*. (2015) and Volek *et al*. (2014) who found that increased fat intake led to increased EE coefficient of total tract apparent digestibility.

On the other hand, the CF digestibility of the experimental rations shows inconsistent values compared to the control group.

The fiber content specially NDF and ADF in corn is not converted to ethanol and hence DDGS contains approximately 35% insoluble fibers and 6% soluble dietary fiber (Stein and Shurson, 2009) which reduces digestibility of DM in monogastric; however in rabbit 40% of fiber is degraded before caecum. The other fiber are digested in the caecum in a fermentation process to produce volatile fatty acids (VFA) as energy source which directly are absorbed in lower tract (Fernandize *et al*., 1994).

Carcass characteristics:

Table (5) illustrates the carcass characteristics of the four treatment groups. In this experiment the live body weight of all treatment groups showed slight differences, the carcass weight increased by the increased level of DDGS in the diet with highest value recorded for the treatment group which received 30% DDGS compared to the control group (1312 gm *vs*. 1213 gm) as per dressing percentages, the inclusion of DDGS improved the values with the highest value (53.03%) recorded for the treatment group received diet containing 30% DDGS.

Table 5. Effect of experimental treatments on carcass characteristics

Parameters	Control	10%DDGS	20%DDGS	30%DDGS	LSM
LBW, g	2458	2339	2466	2495	122.26
CW, g	1213	1209	1303	1322	59.58
DR%	49.43	51.73	52.83	53.03	1.30
FP, g	389.00	394.33	443.00	445.67	17.97
MP, g	332.00	328.00	348.33	359.33	20.24
HP, g	492.33	486.67	511.33	516.67	25.28
FPP%	32.10	32.67	34.00	33.73	0.73
MPP%	27.33	27.10	26.733	27.17	0.50
HPP%	40.57	40.233	39.267	39.10	0.48

^{a,b,c} values in the same row within section with different superscripts differ (P<0.05).

LBW=Live body weight; CW=Carcass weight; DR= Dressing rate; FP= Fore part; FPP%= Fore part percentage; MP= Middle part; MPP% = Middle part percentage; HP= Hind part; HPP%=Hind part percentage.

In general, the percentages of fore, middle and hind parts showed negligible differences from the control group. Pla and Cervera (1997) found no difference in carcass traits or dissectible fat percentage of rabbits fed diets enriched with either animal fat or vegetable oils. The same findings were obtained also, by Pla *et al*. (2008) except for the carcass percentage which showed detectable difference in favor of rabbits fed diets enriched with animal fat. The findings of carcass traits in this particular work confirm with the research studies of Alagón *et al*. (2015) who found no effect on most carcass traits of rabbits fed 20%, 40% corn or barley DDGS and Fernandez *et al*. (1994) who used soybean oil to test the influence of dietary fat inclusion on growth, carcass characteristics of rabbit meat and found no effect on dressing percentage or the main carcass measurements.

The chemical analysis of eye muscle (*longissimus dorsi*) (Table 6) showed slight increase in the water content of the carcass by increased DDGS level which may be attributed to increased level of fat content of the diet, consequently, there was a minor decrease of the dry matter content.

Table 6. Effect of experimental treatments on chemical analysis of eye muscle (*longissimus dorsi*)

Parameters	Control	10%DDGS	20%DDGS	30%DDGS	LSM
Moisture%	73.00	73.43	73.83	74.00	0.52
DM%	27.00	26.57	26.17	26.00	0.52
CP%	20.57^{c}	20.97^{b}	21.13^{b}	21.90^{a}	0.11
EE%	11.27^{c}	13.23^{b}	14.27^{ab}	15.40^{a}	0.48
Ash %	1.34^{b}	1.37^{b}	1.49^{a}	1.51^{a}	0.03
PFV* Kcal/kg	186.9^{c}	206.5^{b}	216.5^{ab}	229.9^{a}	4.49

^{a,b,c} values in the same row within section with different superscripts differ (P<0.05). *PFV=Physiological fuel value

Crud protein content increased significantly (P<0.05) by increased level of DDGS inclusion compared to the control group. In contrast, Alagón *et al*. (2015) reported a decrease in meat protein content of rabbits fed 20% DDGS compared to control group with no differences in intramuscular fat content of the *longissimus dorsi* muscle.

The fat content showed a significant (P<0.05) increase among groups and reached its highest percentage (15.4%) for the group fed 30% DDGS and have a total fat intake of 147.66 gm (Table 3). Fernandez *et al*. (1994) stated that the main measurements of carcass were not influenced by fat in rabbit diets but rabbits fed the highest fat percentage had the highest weight and highest body fat content. Ash percentage increased significantly (P<0.05) in groups received 20% and 30% DDGS.

Physiological fuel value (PFV KCal /Kg) increased significantly (P<0.05) by increasing the level of fat intake. It is obvious that although a minor water content difference was noticed but could be neglected and it was not correlated to the significant differences detected for fat content, and this relationship did not confirm with that obtained by Hernandez *et al*. (1998) and Maj *et al*. (2008) who found a negative correlation between meat water and fat content. The fat content of the control group and the treatments groups when calculated as fresh basis were 3.7%, 5.1%, 5.45% and 5.92% for the control and the groups fed diets containing 10%, 20% and 30% DDGS, respectively.

These findings are in accordance with the results reviewed by Combes (2004). However, it was suggested by many other authors that fat content of rabbit meat depend on muscle type and feeding method (Dorota *et al*., 2010 and Szkucik and Pyz-Lukasik, 2009). Therefore, it is obvious in this study that the fat content of the eye muscle (*longissimus dorsi*) was influenced by the level of DDGS inclusion in the diet, but still keeping the low fat content of the carcass which characterizes the rabbit meat as healthy food.

Fatty acids profile:

Table (7) showed that fatty acids profile of eye muscle (*longissimus dorsi*) of rabbits fed on different levels of DDGS in their diets compared to control group. Rabbits fed diets with DDGS showed a linear decrease in their content of Myristic acid (C14) and Palmitic acid (C16) but the Stearic acid (C18) increased significantly (P< 0.05).

Total saturated fatty acids (TSFA) showed lower values when feeding 20% and 30% DDGS. However the differences were not significant as for the monounsaturated fatty acids. Although the monounsaturated fatty acids (MUFA) showed non-significant decreasing total values, however, the Gadoleic acid (C20:1) decreased significantly (P<0.05) by the inclusion of DDGS in the diet. Polyunsaturated fatty acids (PUFA) showed pronounced increase (yet insignificant) by inclusion of DDGS in the diets (12.03% *vs*. 9.70%) for 30 % *vs*. control group.

Table 7. Fatty acid profile (% of total fatty acids) of *longissimus dorsi* of rabbits fed diet supplemented with different levels of DDGS

Fatty acid profile	Control	10% DDGS	20% DDGS	30% DDGS	LSM
Myristic acid, C14:0	3.53^{a}	3.03^{b}	2.80^{b}	2.72^{b}	0.14
Pentadecanoic acid, C15:0	0.69	0.85	0.77	1.06	0.16
Palmitic acid, C16:0	37.43	36.72	34.83	34.45	0.94
Heptadecnoic acid, C17:0	0.77	1.10	0.96	0.77	0.10
Stearic acid, C18:0	5.74^{b}	8.20^{a}	7.57^{a}	7.33^{a}	0.45
TSFA	48.16	49.89	46.92	46.32	1.40
Phytosteric acid, C14:1ω5	0.52	0.36	0.46	0.45	0.06
Palmitioleic acid, C16:1ω7	5.47	4.37	4.82	4.19	0.40
Oleic acid, C18:1ω9	30.77	30.14	31.27	30.53	1.01
Gadoleic acid, C20:1ω9	0.86^{a}	0.72^{b}	0.74^{ab}	0.66^{b}	0.04
Eicosaenoic acid, C20:1ω7	1.06	0.29	0.38	0.53	0.08
11-eicosaenoic acid, C20:1ω5	0.20	0.88	1.02	1.07	0.11
TMUFA	40.24	37.91	42.32	39.48	1.27
Hexagonic acid, C16:3ω4	0.31	0.34	0.38	0.33	0.02
Linoleic acid, C18:2ω6	9.01	9.93	11.21	11.47	0.10
Linolenic acid C18:3ω3	0.39	0.52	0.51	0.51	0.11
TPUFA	9.70	10.8	12.1	12.3	1.09

^{a,b} values in the same row within section with different superscripts differ (P<0.05).

SFA= Saturated fatty acids; MUFA= Monounsaturated fatty acids; PUFA= Polyunsaturated fatty acids.

The polyunsaturated fatty acids have a stimulating effect on enzymes that degrade fatty acids (Crespo and Esteve-Garcia 2002) which consequently affect the deposition of fat in the body. The fatty acid profile of the eye muscle (*longissimus dorsi*) meat in this particular work is not different from other authors on rabbits. Dal-Bosco *et al*. (2012) and Kouba *et al*. (2008) found higher values in SFA than in PUFA.

Rabbit as a monogastric is able to incorporate the long chain fatty acids in the adipose tissue and intramuscular lipids directly from the diets (DalleZotte, 2002).

Feeding diets high in monounsaturated fatty acids to rabbits showed that the meat produced contain higher levels of Oleic acid (C18:1). Feeding polyunsaturated fatty acids in the diets produced higher level of Linoleic acid (C18:2) Lopez-Boto *et al*. (1997).

It is worth noting that the linoleic acid in the diets containing DDGS increased respectively, by increased level of DDGS inclusion. Linoleic acid is deposited directly, into the fat of animal (Wood *et al*., 2008).

In general, there were no unfavorable changes in the fatty acids profile due to feeding diets enriched with DDGS compared to control group. The increased values of linoleic and linolenic acid make the rabbit meat a rich source of such favorable fatty acids for human consumption.

In conclusion: the results of this particular study showed that using DDGS in growing rabbit diets up to 30%, even if DDGS contain high ether extract (EE %) reduced feed intake (FI) and improved feed conversion (FC). No significant effect on carcass traits and composition with a minor improvement in dressing percentage.

The fatty acids profile showed no effect on SFA%, minor decrease of MUFA% and remarkable increase in PUFA %. In this study SFA represents 48 % of the total fatty acids with high Palmitic acid (C16:0) percentage. MUFA represents 49% with Oleic acid (C18:1) as the abundant fatty acid (30 %). PUFA showed that Linoleic acid (C18:2) is the most abundant fatty acid.

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تأثير استخدام مستويات متزايدة من نواتج تقطير الأذرة فى علائق الأرانب النامية على الأداء الإنتاجى وصفات الذبيحة وصورة الأحماض الدهنية

أمانى وجيه يوسف، سها سيد عبد المجيد، نانسى نبيل كامل، عمرو حسين عبد الجواد، حاتم محمد على

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استخدم فى هذا البحث ٣٦ أرنب ذكر نامى نيوزيلاندى عمر ٦ أسابيع لدراسة تأثير استخدام نسب متزايدة من نواتج التقطير الأذرة DDGS على معدلات النمو وتحويل الغذاء وصفات الذبيحة وصورة الأحماض الدهنية في اللحم الناتج. قسمت الأرانب إلى ٤ مجموعات كل مجموعة ٩ أرانب وكل مجموعة ٣ مكررات كل مكرر ٣ أرانب وغذيت المجموعات على علائق تحتوى على صفر، ١٠، ٢٠، ٣٠% نواتج تقطير الأذرة إستبدالا من نسبة كسب الصويا والأذره وبحيث كانت العلائق متساوية فى محتواها من الطاقة والبروتين. وفى نهاية التجربة التى استمرت لمدة ١٢ أسبوع استخدمت ٣ أرانب من كل مجموعة لتقييم معاملات هضم العلائق المستخدمة كما تم ذبح ٣ أرانب من كل مجموعة لدراسة خصائص الذبيحة ونسب التصافى. وكما تم تقييم صورة وتوزيع الأحماض الدهنية فى العضلة العينية للمجموعات التى تم تغذيتها على علائق محتوية على نسب متزايدة من نواتج تقطير الأذره. وتشير النتائج إلى أن إضافة نسب متزايدة من نواتج تقطير الأذره قد أدى إلى تناقص المأكول من الغذاء وحسن من كفاءه التحويل الغذائى. ولم يكن هناك فروق ملموسة بين مجموعات التجربة فى معاملات هضم المادة الجافة والمادة العضوية والبروتين الخام ولكن سجلت معاملات هضم الدهون قيماً متزايده بزيادة نسبة نواتج التقطير فى العلائق بينما كانت معاملات هضم الألياف متقاربة وبالنسبة لمواصفات وخصائص الذبيحة فقد سجلت نسبة التصافى أرتفاعاً بسيطاً بزيادة نسبة نواتج التقطير فى العلائق بينما زادت نسبة الدهن فى الذبيحة زيادة معنوية. وكانت التغيرات فى صورة وتوزيع الأحماض الدهنية طفيفة مع زيادة ملحوظة غير معنوية فى الأحماض الدهنية غير المشبعة من النوع عديد الروابط.