Kingdom of Saudi Arabia
King Faisal University
Department of Animal Sciences
&
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Final Report

on

Use of Canola Seeds (Brassica Napus, L.) in the Poultry Rations

By

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// 1. English Abstract

The high price of corn and soybean meal and their scarcity sometimes necessitated the search for locally produced ingredients that can partially replace the corn and SBM.

Canola seeds are originated in North America as a source of good edible oil for human consumption. Meal of these seeds (by-product of oil extraction) can be used in the poultry diets. Research in this area proved that canola seeds could be successfully planted in Al-Hassa area of Saudi Arabia. The study reported here-in was conducted as a result of cooperation between the department of crop Sciences which planted and provided the canola and the Department of Animal Sciences that conducted the experiment.

The objectives of this study were to determine the chemical analysis and metabolizable energy of a locally produced full fat canola seeds (LPFFCS). Also to determine the possibility of using whole or ground canola seeds in the diets of layers and broilers.

Chemical analysis and TME determination:

The chemical analysis of the seeds showed that it contained 95.4 % DM, 25.6 % CP, 38.2 % EE, 4 % ash and 6.8 % CF. ME, calculated from the determined TME showed a 4128 Kcal /kg value. Essential and non-essential amino acids were also determined as well as Na, Cl, Ca, P, Cu. Zn and Fe. It was concluded that with the exception of protein level canola seeds are very much similar to SBM in many aspects.

Layer experiment:

Five levels of whole canola seeds; 0, 5, 10, 20, and 30 % were used in the diets of 100 white leghorn pullets at age of 20 weeks. Each of these dietary treatments was distributed randomly on 5 cages (reps) containing 4 birds, each.

The results of this experiment provided evidence that including up to 10 % whole canola in the layer diet made no harm to the performance of these birds in terms of hen-day egg production, egg mass, feed conversion and egg weight. Feed intake increased with increasing level of canola seeds in the diet. However most of these differences were season dependent. Hen-day production, egg mass and egg weight were very much lower when birds fed 30 % canola. The highest production rate was found in the fall season when birds fed 5 and 10 % canola seeds (90 and 88 %, respectively). No specific trend was observed on the effect of canola on egg specific gravity and yolk index. However, haugh unit was higher, yolk color was darker, weight gain was lower in birds fed 30 % canola seeds.

It was concluded that incorporating up to 10 % LGFFCS in the layer diet might benefit the producer if economically priced.

Broiler experiment:

Four levels of whole canola seeds; 5, 10, 20, 30 % and same levels of ground canola seeds and a control (0 %) were included in the diets of 360 broiler chicks in such away that each treatments was fed to 40 birds (4 reps, each, 10 birds).

The results of this study exhibited a negative effect of canola seeds on performance of broilers from hatch to 6 weeks of age.

Although, treatment levels did not significantly affect feed intake in birds fed canola seeds, weekly weight gain was much lower than that of the control during the first 4 weeks of the trial. Small improvement occurred in weeks 5 and 6. Feed conversion followed similar trend to weight gain. Most of the mortality occurred in birds fed 30 % canola. Grinding the canola exacerbated the problems.

The accumulated performance of the broilers in week 6 provided clear evidence that with exception of 5 % treatment, increasing level of canola

from 0 to 30 % had negatively affected final body weight, mortality and feed conversion. However, cumulative feed intake did not significantly differ among treatments. Despite level of canola, higher intake was observed in birds fed whole seeds.

Cumulative livability was very low in birds fed 30 % canola seeds. When form of canola is concerned, livability was better in birds fed whole canola seeds.

Dressing analysis showed no significant differences among treatments pertaining to dressing %, fat % of dressed or live birds. However, fat weight was much lower in birds fed 30 % canola seeds. Regardless of canola level, birds fed whole canola had more fat than those fed ground canola. Numerically, males had higher dressing % and less fat than females.

It was concluded that feeding more than 5 % LGFFCS to broiler from hatch to 6 weeks of age could be harmful. Grinding canola may cause more damage. Therefore it is suggested more studies are needed to determine the validity of feeding this type of canola to broilers at different ages.

٢. الخلاصة العربي:

ارتفاع اسعار الذرة الصفراء و فول الصويا وشحتهم في بعض الأحيان حفز الباحثين للتفتيش على مصادر علفية منتجة محليا ممكن ان تحل جزئيا محل الذرة الصفراء وفول الصويا.

نشأت بذور الكانولا في شمال أمريكا وكانت اساسا تستخدم كمصدر لزيت عالي الجدودة لإستهلاك الإنسان. وقد اثبت البحاثة هناك ان من الممكن إضافة الكانولا الكاملة او كسبتها (ناتج عصر الزيت) في علائق الدواجن. أثبتت دراسات في المملكة العربية السعودية انه امكن زراعة الكانولا بنجاح في منطقة الإحساء. وقد نفذ البحث الحالي نتيجة للتعاون بين قسمي المحاصيل الذي زرع الكانولا وقسم علوم الإنتاج الحيواني والذي نفذ الدراسات.

إن اهداف هذا البحث كانت لتقدير التركيب الكيميائي لبذور الكانولا الكاملة الدسم والمنتجة محليا شاملة تقدير الطاقة الممثلة الحقيقية للبذور وكذلك لدراسة امكانية استخدام حبوب الكانولا بشكليها الكامل والمطحون في علائق الدجاج اللاحم والبياض.

التحليل الكيميائي وتقدير الطاقة:

أظهر التحليل الكيميائي للبذور انها تحتوي على ٩٥,٤ % مادة جافة ، ٢٢,٦ % بروتين خام ، ٣٨,٢ % دهون ، ٦,٨ % الياف خام. وقد حسبت الطاقة الممثلة للبذور بإستخدام نتائج تقدير الطاقة الممثلة الحقيقية حيث بلغت ٤١٢٨ كيلوكالوريس/كجم. بالإضافة الى ذلك فقد تم تقدير الأحماض الأمينية الضرورية وغير الضرورية بالإضافة الى المعادن التالية : صوديوم ، كلورايد ، فسفور ، نحاس ، زنك و حديد. وقد استخلص من نتائج هذه التحليلات انه بإستثناء مستوى البروتين فإن بذور الكانولا تشابه بذور فول الصويا في اوجه كثيرة.

تجربة الدجاج البياض:

تم استخدام ٥ مستويات من بذور الكانولا الكاملة : صفر ، ٥ ، ١٠ ، ٢٠ و ٣٠ % في علائق ١٠٠ فرخة ليجهورن بيضاء في عمر ٢٠ اسبوع. وقد تم توزيع كل معاملة من هذه المعاملات على ٥ اقفاص (مكررات) كل قفص يحتوي على ٤ فرخات.

وقد برهنت نتائج هذه التجربة على ان إضافة الى حد ١٠ % من بذور الكانولا في علائق الدجاج البياض لم يؤثر سلبا على ادائها من حيث انتاج البيض اليومي ، كتلة البيض ، معدل التحويل الغذائي ووزن البيض. وقد لوحظ زيادة استهلاك العلف بزيادة مستوى الكانولا في العليقة. إلا ان معظم هذه الإختلافات كانت مرتبطة بفصول السنة. فقد وجد انتاج البيض وكتلة البيض ووزنه كانوا الأقل عند تغذية الطيور ٣٠ % كانولا كما ان اعلى انتاج وجد في موسم الخريف عندما تغذت الطيور على ٥ و ١٠ % كانولا (٩٠ و ٨٨ % على التوالي).

لم يلاحظ أي تغير معين في الوزن النوعي للبيض و معامل الصفار عند إضافة الكانولا الا انه وجد ان وحدات هوف كانت اعلى ولون الصفار كان اغمق عند إضافة ٣٠ % كانولا للعليقة.
استخلص من نتائج هذه التحربة ان إضافة الى ١٠ % كانولا كاملة الدسم الى علائق الدجاج البياض ممكن ان يكون ذا فائدة للمنتج اذا كانت الأسعار مجزية اقتصاديا.

تجربة الدجاج اللاحم:

تم إضافة ٤ مستويات من الكانولا الكاملة و مثلها من المطحون و شاهد مشترك الى علائق ٣٦٠ صوص لاحم بحيث ان كل معاملة اعطيت الى ٤٠ طائر (٤ اقفاص (مكررات) يحتوي كل على ١٠ طيور).

نتائج هذه التجربة أظهرت تأثير سلبيا لإضافة الكانولا على اداء الدحاج اللاحم من عمر الفقس الى عمر ٦ اسابيع.

ولو ان مستوى المعاملات لم يؤثر سلبيا على استهلاك العلف الا ان الزيادة الوزنية الأسبوعية كانت اقل بشكل كبير من الشاهد خلال الأربعة اسابيع الأولى من التجربة. بالمقابل حصل تحسن بسيط في الأسابيع ٥ و ٦. كما تأثر معدل التحويل الغذائي سلبيا بنفس اسلوب الزيادة الوزنية ومعظم النفوق حصل في الطيور التي غذيت على ٣٠ % كانولا. ويبدو ان طحن الكانولا قد زاد من التأثير السيئ لإضافة الكانولا على الدجاج اللاحم.

وقد برهن اداء الطيور المتراكم بشكل واضح انه مع استثناء معاملة ٥ % كانولا فإن زيادة مستوى الكانولا في علائق اللاحم من ٠ الى ٣٠ % قد اثر سلبا على وزن الطيور النهائي ، النفوق و معدل التحويل الغذائي. إلاّ ان كمية العلف المستهلكة الى نهاية الأسبوع السادس لم تتأثر معنويا. وبصرف النظر عن مستوى المعاملات فقد لوحظ زيادة في استهلاك الطيور المغذاة على على كانولا كاملة.

حيوية الطيور عند اسبوع ٦ كانت قليلة جدا في حالة الطيور المغذاة على ٣٠ % كانولا. ويبدو ان الطيور التي تناولت الكانولا كاملة كانت حيويتها أفضل.

أظهرت نتائج عمليات الذبح انه لا توجد فروق معنوية بين المعاملات فيما يخص نسبة التصافي ، نسبة الدهون منسوبة الى وزن المذبوح المنظف او الى الطائر الحي. إلاّ انه لوحظ أن وزن الدهن كان اقل في حالة الطيور المغذاة على ٣٠ % كانولا. وبصرف النظر عن مستوى الكانولا فإن الطيور المغذاة على كانولا كاملة رسّبت اكثر دهنا من المغذاة على كانولا مطحونة. وبنفس السياق رسّبت الذكور عدديا اقل دهنا واعطت نسبة تصافي اعلى من الإناث.

وقد خلص الباحثون الى ان إضافة اكثر من ٥ % من الكانولا الكاملة الدسم الى علائق اللاحم من عمر الفقس والى ٦ أسلبيع ممكن ان يكون مضرا وان طحن الكانولا قد يزيدها ضررا. لذا

فإنه يقترح إجراء دراسات أكثر لتقييم امكانية استخدام بذور الكانولا بأشكال مختلفة مع الدجاج اللاحم عند أعمار مختلفة.

3. Introduction and Literature Review:

Corn and Soybean are considered the most valuable ingredients in Poultry rations when energy and protein are concerned. However, these grains are not grown in Saudi Arabia due to the unfavorable weather conditions, therefore, they are imported from different countries and that usually is subjected to the laws of international commerce. The most efficient substitute for these ingredients has not been established yet and the reason that any of the ingredients used as a substitute in tens of research studies was either badly performed or economically not feasible to use. Several ingredients have been tested such as date as a substitute for corn in the layer ration (Najib *et al*, 1994) and Selicornia as a substitute for SBM in the poultry diet (Glen, 1994; and Al-Batshan *et al*., 2001). Research for new ingredients has not stopped and yet there have been several crops under investigation.

Canola is a winter crop that is widely grown around the world. There was an increase demands for the oil of this crop which necessitated the increase in production especially in the industrial countries like US and Canada where soybean production is not suitable. However, countries, known for their harsh environment like Saudi Arabia and Egypt are also able to plant the canola.

Canola was originally derived from rapeseed varieties, it’s component have been altered through genetic selection which markedly reduced it’s detrimental components, erucic acid and the glucosinolates to a negligible level and to less than 20 µg/g, (Leeson and Summers, 2001). These levels are low enough to be of little or no harm to poultry. Other toxins such as tannin, sinapine may also cause some problems if present in high level such in case of sinapine may cause a fishy odor in some brown egg birds (Leeson and Summers, 2001). This fishy flavor may be due to to the trimethylamine that resulted from the degradation of sinapine in the intestinal tract, the authors further added. Some of today's brown layers lack the ability to produce trimethylamine oxidase, an enzyme able to degrade the trimethylamine, which resulted in depositing it into the egg.

Full-Fat Canola Seeds (FFCS) are not normally used as feedstuff for poultry due mainly to the pricing of edible oil. However, with 40 % fat and 20 % protein (Summers and Leeson, 1985) it could be an alternative source of energy and protein for poultry when it is economically priced. Research in the area of its use as feedstuff has been controversial. Leslie and Summers (1972) reported a decrease in feed intake and egg production with an increase in dietary proportion of raw rapeseeds. Summers *et al*. (1982) also reported that 17.5 % or more of full-fat canola in diets of broilers lowered both body weight gain and feed intake, although feed efficiency was similar to that of broilers fed a control diet. Likewise Nwokolo and Sim (1989) reported depressed egg production in hens, fed barely-full-fat canola seeds (FFCS). Shen *et al*. (1983) showed that if the seeds were finely ground or if the seeds were stem pelleted in order to rapture the coat, good results with up to 20 % whole canola seeds could be expected.

3.1. Objectives:

These experiments were conducted to:

1. Determine the TME of the locally grown Full-fat Canola seeds and their proximate analysis.
2. Determine the possibility of using the locally grown Full-fat canola seeds un the diets of layers and broilers.

3.2. Utilization

Since oils of the Canola are palatable for human and high in energy and protein, it is expected that partial replacement with corn or soybean in the poultry rations can be fully achieved with little or no bad effect on performance of the birds. Canola seeds can be grown in Saudi Arabia. Seeds of this plant were proven to be palatable and rich in many nutrients. If the Canola seeds prove to be a good replacement of yellow corn or SBM in the poultry rations, then this grain can be used widely in the poultry rations. This may save much of the hard currency needed to import the yellow corn or SBM.

4. Materials and Methods

4.1. Chemical Analysis:

Samples of ground Canola seeds were subjected to proximate chemical analysis according to the method of American Association of Cereal Chemists (AACC, 1994). Moisture content was determined according to (AACC, 44 – 16) using (Memmert 854 Schwabach drying oven), Ash content was determined according to (AACC, 08 – 01) using (Agallenkamp muffle furnace, England). Crude Protein (CP) was determined according to (AACC, 46 – 10) using Kjeldahl (Kjelteck auto 1030 analyzer). Ether extract (EE) was determined according to (AACC, 30 – 25) using (Soxhelet, HT2 1045 Extraction unit), and Crude Fiber (CF) was determined according to (AACC, 32 – 10) using (Lab Conco, corporation Kansas City, Missouri 64132).

The data obtained from the analysis was compared with that in the literature to determine the validity of the results.

4.2. True Metabolizable Energy (TME) determination.

TME of the seeds was estimated according to the method developed by Sibbald, 1976.

Four White Leghorn Cockerels were housed individually in cages and starved for 24 hours before being forcibly fed 40 gm of ground Canola. Seeds. Two cocks were unfed and used as a control.

Forced feeding was accomplished using a stainless-steel funnel with a 35 cm long stem and 1.3 cm outer diameter and plunger fitted in 0.9 cm outer diameter (Pic. 1 and 2)

The funnel containing the ground Canola seeds was pushed down the esophagus of the cock till the end of the crop was reached. The plunger then pushed the feed in question down the crop of each roaster. Sibbald (1980) suggested that in adult White Leghorn cockerels, the optimum input of test material as pellet was 30 – 40 or 25 –30 gm as ground feed.

The birds fed Canola and that kept unfed (control) were placed in the cages and excreta voided were collected quantitatively after 48 hours (Schang and Hamlton, 1982). The collected feces was dried at 54 °C for 24 hrs in an oven, weighed and left outside the oven to equilibrate with atmospheric moisture.

Ground samples and excreta collected were assayed for gross energy by using a diabatic oxygen bomb calorimeter (AOAC, 1980).

True Metabolizable energy of Canola seeds was estimated using the following equation as adopted by Sibbald, 1976:

$$TME \text{ (Kcal/g air dry)} = (GE_f * X) - (Y_{ef} - Y_{ec})/X$$

Where:

GE_f is the gross energy of the feeding stuff (Kcal/g),
Y_{ef} is the energy voided as excreta by the fed bird,
Y_{ec} is the energy voided as excreta by the unfed bird, and
X is the weight of feedingstuff fed, (g)

Pic.1 The Funnel is being filled with ground canola seeds Canola

Pic. 2 The funnel containing ground is being pushed down the esophagus

4.3. Plantation:

Canola seeds (Brassica Napus, L.) were planted successfully in the lands of King Faisal University Experimental Station. Pictures of the plant are presented next after this paragraph representing different stages of growth (Pic. 3). This plant was proven to resist drought and can be planted in semi arid regions like Saudi Arabia (Leela *et al*., 2002). Brassica Napus is one of three types of Canola, however, this type considered the best since it's level of erucic acid and Glucosinolates do not exceed 2 % and 30 micromole/gm of the meal, respectively). This type called (00) and has 3 cultivars, namely; Bactool, Al-Serwa 4, and Al-Serwa 8. Bactool was the one used in this experiment. Plantation process lasted for 5 months. The expected outcome of the plantation (about one tone) was assumed to be enough to feed the birds in both experiments. However, the harvested amount was less than have anticipated, therefore, the plantation process was repeated the year after. Canola is a seasonal plant.

Pic. 3 Pictures above and below represent the canola plants in different stages of their life

4.4. Birds and feeding

Two experiments were conducted to evaluate the feeding of Canola seeds to broiler and layers.

4.4.1. Layer experiment

4.4.1.1 Procedure during the starting and growing period

Three hundred white leghorn chicks were obtained from local hatchery. After the chick's arrival, they were weighed by groups and fed commercial starter diets, containing 19.8 % crude protein and 2850 Kcal/Kg metabolizable energy (ME). The chicks were kept on the starter diet till reached the breeder's target weight at week 9 when they were switched to the commercial grower diets. The composition of the starter and grower diets is presented in Table 1. During the first ten weeks, the chicks were vaccinated and debeaked. Sample of the vaccination program is presented in Table 2.

Chicks were exposed to continuous lighting during the first week of their life then decreased by one hour weekly till reached 9 hours, at which time it was held constant.

On week 18, 100 pullets were moved to cages in a house where cooling device was installed. Starting week 21, the feeding trial was commenced. Four treatment levels of whole Canola seeds, 5, 10, 20 and 30 % and a control (0 % canola) replaced part of the corn and SBM in the ration. The calculated composition of the experimental diets is presented in Table (3). The treatments were fed to the birds-in-cages at a rate of 5 cages (reps) per treatment, each containing 4 birds. Lighting hours were maintained to 14 hours daily in the house.

Table 1. The suggested dietary composition of the starting and growing rations

Nutrients	starter	grower	
	0 – 4 wk	5 – 12	13 – 20 wk
Crude Protein, %	19.8	18.3	16.7
Metabolizable E, Kcal/Kg	2850.0	2850.0	2900.0
Ca, %	1.0	1.0	1.0
P (available), %	0.4	0.4	0.31

Feedstuff used in the diet of the first period were; grains, SBM, vegetable oil, Synthetic amino acids, vitamins and minerals premix, coccidiostat.
Feedstuff used in the diet of the second period were; grains, SBM, wheat bran, vegetable oil, limestone, DI-calcium p., salt, synthetic methionine, choline chloride, vitamin & minerals premix

Table 2. The vaccination program during the growing period

Age of the bird	Disease	Route of Administration
10 days	Newcastle – B1 + Infectious Bronchitis	Eye drop
18 days	Jumboro	Eye drop
24 days	Lasota	Eye drop
28 days	Jumboro	Eye drop
35 days	Lasota + Infectious Bronchitis	Eye drop
49 days	Fowl Pox	Wing
70 days	Newcastle (oily)	Intra-muscle injection
126 days	Tri vaccines	Intra-muscle injection

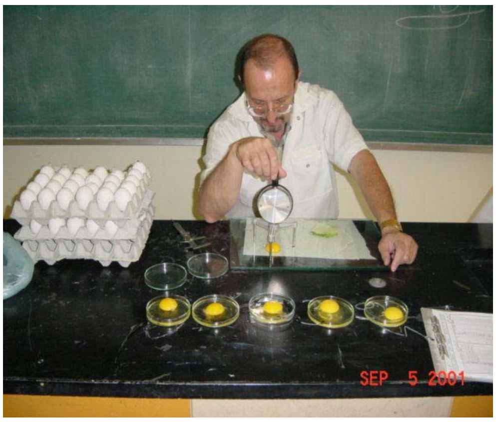
Table 3. The nutritional composition of the dietary treatments (0, 5, 10, 20 and 30 % Canola seeds)

Ingredients	0				
Yellow corn	60.00	58.33	51.38	37.45	23.45
SBM, 44 %	24.0	20.01	19.1	14.45	10.48
Wheat Bran	0.00	1.97	3.55	8.00	14.00
Fish Meal, 72 %	3.00	3.44	2.50	2.00	1.00
Limestone	8.28	7.60	7.74	8.00	7.87
MV Mix[1]	0.20	0.20	0.20	0.20	0.20
DL Methionine	0.40	0.25	0.25	0.30	0.40
Dical Phosphate	0.95	0.70	0.80	1.00	1.00
L-Lysine	0.10	0.00	0.00	0.00	0.00
Choline Cl	0.10	0.00	0.00	0.00	0.00
Salt	0.40	0.40	0.42	0.50	0.50
Corn Oil	1.49	0.00	0.00	0.00	0.00
Anti Oxidant	0.08	0.10	0.10	0.10	0.10
Canola seeds	0.00	5.00	10.00	20.00	30.00
Deh. Alfalfa	1.00	2.00	4.00	8.00	11.00
Total	100.00	100.00	100.04	100.00	100.00
Calculated Composition					
Crude protein, %	18.00	18.00	18.00	18.00	18.00
ME, kcal/kg	2800	2800	2800	2800	2800
Calcium, %	3.53	3.25	3.35	3.57	3.57
Av. Phosphorus,%	0.34	0.31	0.32	0.36	0.37
Riboflavin, mg/kg	1.71	1.90	2.08	2.57	2.97
Niacin, mg/kg	24.59	32.15	37.75	51.84	68.08
Pantothenic Acid, mg/kg	7.04	7.56	8.29	9.95	11.81
Choline, mg/Kg	1306	1402	1577	1939	2268
Methionine, %	0.68	0.56	0.55	0.61	0.70
Cystine, %	0.29	0.30	0.30	0.31	0.33
Meth + Cyst, %					
Lysine, %	1.14	1.05	1.06	1.09	1.10
Tryptophan, %	0.24	0.24	0.25	0.26	0.28
Linoleic Acid, %	1.42	1.81	2.08	2.64	3.23

[1.] Vitamin & Minerals mix provided the following per Kilogram of the diet: Vit. A, 6,670,000; Vit. D^3, 1,340,000; Vit. E, 5000 mg; Vit. K3, 2,680 mg; Vit. B2, 3000 mg; Vit. B^6, 2000 mg; Vit. B^{12}, 10000 mcg; Nicotinamide, 16,670 mg; Ca d-Pantothenate, 5,340 mg; Folic Acid, 334 mg; Choline Chloride 200,000 mg; Manganese, 66,700 mg; Zinc, 26700 mg; Iron, 33,400 mg; Copper, 1600 mg; Cobalt, 134 mg; Iodine, 234 mg; Selenium, 54 mg; Antioxidant 2000 mg

4.4.1.3. Procedure during the laying period

Eggs were collected daily however, calculation of hen-day egg production and egg weight were made on bi-weekly basis. At the end of each 28-day period, three days of egg collection were used for shell quality determination, haugh unit (albumin height) and yolk color (Pic 4 and 5). Specific gravity method was used to measure the shell quality of the eggs. This method was described in (North, 1984). Eggs in-baskets were consecutively immersed in nine salt solutions of different specific gravities ranging from 1.060 to 1.10 with an increment of 0.005. Eggs that float were given the designated specific gravity value of that bucket. The higher the specific gravity values the better the shell quality. Feed was given ad-libitum daily. Feed left was weighed at the end of each week to determine feed intake. The feeding trial continued for 24 weeks



Pic. 4 Haugh unit and Yolk index are being measured in the lab

Pic. 5 Color index is being measured according to the colors gradients

4.4.2. Broiler Experiment

Five hundred chicks were purchased from a local hatchery. Three hundred sixty chicks, were selected and distributed intermingled in 36 battery pens, each contained 10 chicks. These battery pens were equipped with source of heat, feeders and waterers.

Five levels of ground and whole Canola seeds replaced part of the SBM and corn in the ration at the rate of 0, 5, 10, 20 and 30 %. These dietary treatments were assigned to the cages in such a way that each dietary treatment was assigned to 4 battery pens (replications). There was one control for both types of feed (0 % canola). Tables 4 and 5 represent the dietary treatments and the calculated composition of the diets that were fed to the birds from day 1 to 4 weeks (starter diet) and from week 5 to the end of the experiment (finisher diet).

Birds were weighed individually every week and weight gain was determined according to that. Feed was added as necessary and weekly and cumulative feed intake was determined from feed left as opposed to feed given. Weekly mortality was calculated based on number of birds died in specific day of the week.

Four birds, two males and two females were slaughtered for dressing analysis. The experiment lasted 45 days.

Table 4. The dietary treatments of Broiler (Starter) experiments

Ingredients, %	Canola seeds, %				
	0.00	5.00	10.00	20.00	30.00
Yellow Corn	56.00	53.00	51.50	43.00	34.00
SBM, 44 %	30.2	29.0	28.2	21.7	22.3
Wheat bran	0.00	0.80	0.00	5.70	8.00
Fish meal	5.50	4.86	4.20	4.85	2.00
Limestone	1.20	1.23	1.24	1.29	1.30
Vit & Min	0.20	0.25	0.25	0.25	0.25
DL Meth	0.30	0.16	0.21	0.16	0.19
Di Ca P	1.39	1.38	1.44	1.40	1.51
L-lysine	0.00	0.00	0.05	0.00	0.00
Choline Cl	0.00	0.00	0.00	0.02	0.00
Salt	0.20	0.25	0.25	0.25	0.25
Veg. Oil	4.96	3.97	2.61	1.28	0.10
Antioxidant	0.10	0.10	0.10	0.10	0.10
Canola	0.00	5.00	10.00	20.00	30.00
Total	100.05	100.00	100.05	100.00	100.00
Chemical Composition					
Metabolizable E. (ME), Kcal/Kg	3200	3200	3200	3200	3200
Protein, %	22	22	22	22	22
Ca, %	1.00	1.02	1.03	1.08	1.09
AP, %	0.47	0.47	0.48	0.49	0.49
Methionine, %	0.67	0.55	0.59	0.57	0.58
Cystine, %	0.34	0.34	0.35	0.35	0.37
Lysine, %	1.34	1.33	1.37	1.31	1.30
Choline, mg/Kg	1481	1593	1702	1959	2158
Pant. Acid, mg/Kg	8.00	8.08	7.78	8.78	9.25
Riboflavin, mg/Kg	1.98	1.95	1.87	2.04	1.91
Niacin, mg/Kg	27.30	31.74	33.63	50.13	58.97
Tryptophan, %	0.30	0.30	0.30	0.30	0.32
Linoleic acid, %	3.84	3.69	3.36	3.38	3.43

[1] This mixture provided the following per kilogram of diet: Vit A, 10000IU; Vit D3, 5500 ICU; Vit E, 8 mg; Choline, 20 mg; Vit B1, 1.5 mg, Vit B2, 4 mg; Vit B6, 0.8 mg; Niacin, 20 mg; PA, 8 mg; Folic Acid, 0.8 mg; Biotin,0.08 mg; Vit C, 80 mg; Ethoxyquin, 56 mg; Cu, 12 mg; I, 0.9 mg; Fe, 80 mg; Mn, 80 mg; Zn, 48 mg; Co, 0,04 mg; Se, 0.16 mg.

Table 5. The dietary treatments of Broiler (finisher) experiments

،Ingredients	Canola seeds, %				
%	0.00	5.00	10.00	20.00	30.00
Yellow Corn	58.00	53.00	51.70	48.00	38.27
SBM, 44 %	22.8	20.3	20.5	18.4	15.95
W. BRAN	4.50	8.00	6.80	6.10	11.00
FISH M.	5.60	5.11	4.00	2.90	1.00
L. STONE	1.40	1.37	1.33	1.36	1.36
MVMIX	0.25	0.25	0.25	0.25	0.30
DL. METH	0.07	0.08	0.08	0.11	0.11
DIC. PHO	1.48	1.61	1.51	1.62	1.62
L-LYSINE	0.02	0.00	0.01	0.03	0.03
CHOL-CL	0.20	0.00	0.00	0.00	0.00
SALT	0.25	0.25	0.25	0.25	0.25
VEG. OIL	5.33	4.93	3.47	0.90	0.01
ANTIOXIDANT	0.10	0.10	0.10	0.10	0.10
CANOLA	0.00	5.00	10.00	20.00	30.00
Total	100.00	100.00	100.00	100.02	100.00
Chemical Composition					
Metabolizable E. (ME), Kcal/Kg	**3200**	**3200**	**3200**	**3200**	**3200**
Protein, %	**20.00**	**20.00**	**20.00**	**20.00**	**20.00**
Ca, %	1.09	1.10	1.07	1.11	1.10
AP, %	0.48	0.51	0.48	0.50	0.49
Methionine, %	0.44	0.45	0.44	0.47	0.46
Cystine, %	0.31	0.31	0.32	0.33	0.34
Lysine, %	1.18	1.13	1.14	1.15	1.11
Choline, mg/Kg	1469	1453	1563	1787	1991
Pant. Acid, mg/Kg	8.32	8.97	8.64	8.24	9.16
Riboflavin, mg/Kg	2.00	2.05	1.94	1.82	1.81
Niacin, mg/Kg	34.11	42.85	43.92	49.29	62.80
Tryptophan, %	0.26	0.26	0.27	0.27	0.27
Linoleic acid, %	4.12	4.25	3.87	3.29	3.50

[1] This mixture provided the following per kilogram of diet: Vit A, 10000IU; Vit D3, 5500 ICU; Vit E, 8 mg; Choline, 20 mg; Vit B1, 1.5 mg, Vit B2, 4 mg; Vit B6, 0.8 mg; Niacin, 20 mg; PA, 8 mg; Folic Acid, 0.8 mg; Biotin,0.08 mg; Vit C, 80 mg; Ethoxyquin, 56 mg; Cu, 12 mg; I, 0.9 mg; Fe, 80 mg; Mn, 80 mg; Zn, 48 mg; Co, 0,04 mg; Se, 0.16 mg.

4.4.2.1. Vaccination

A vaccination program was used to vaccinate the Broiler chicks during the first 28 days of their life. This program is presented in Table 3.

Table 6. Vaccination program of the Broiler

NO	Disease	Vaccine name	Method of vaccination	Vaccination period
1	New castle	Hb1	Eye	10^{th} day
2	New castle	Lasota	Eye	3^{rd} wk
3	Jumboro	Bursal	Eye	18^{th} & 28^{th} days

Slaughtering process

This procedure was conducted in the slaughter house of the Poultry Unit at the experimental station of King Faisal University. The slaughtering machine is a semi-automatic, comprising of three main parts, the killing and bleeding, the immersing in hot water (temperature 58 °C) and the defeathering. Evisceration was done manually (Pic. 6).

Birds from each pen, 2 females and 2 males were taken, weighed, slaughtered, defeathered and eviscerated. Head, legs, viscera were discarded and the dressed bird was weighed again. Abdominal fat was removed and weighed separately. Dressing and fat percentages were determined based on dressed and live weight.

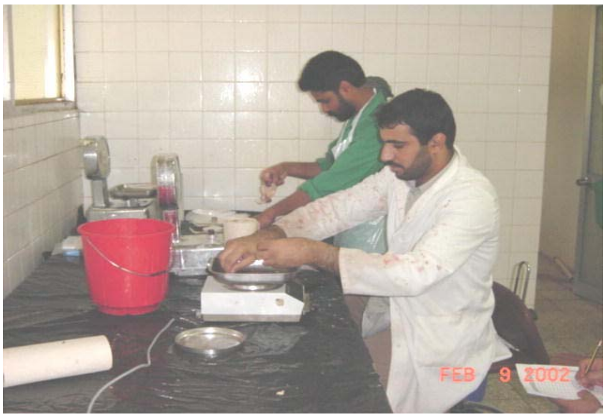

1. Slaughtering


2. Immersing in hot water


3. Defeathering


4. Dressed birds weighing


5. Viscera weighing


6. Fat pads weighing

Pic. 6. Series of steps representing the processing of broilers in the University slaughter house

4.5. Statistical Analysis:

In experiment 1, Summarized data for all response variables were subjected to combined analysis in Completely Randomized Design where Level of canola (TRT) was considered the main effect on traits while period of the year (P) was the secondary effect. Replication within period P(R) was the first error term carrying 8 degrees of freedom (Steel and Toori, 1980). The mathematical model of this arrangement is presented in the next paragraph. General Linear Models procedure in the PC-SAS® (SAS Institute, 1988) was used to estimate the variations among the means. Variable means showing significant differences in the analysis of variance table were compared using the Duncan Multiple Range Test (Steel and Toori, 1980).

The mathematical model used to estimate the effect of treatment levels and period on traits was as follows:

$Y_{ijk} = \text{Ц} + T_i + P_j + P(R)_{jk} + T_i*P_j + e_{ijk}$

Where:

Y_{ijk} is the effect of $_i$th treatment and $_j$th period on $_k$th pen

Ц is the overall mean

T_i is the effect of treatment, i = 1......5

P_j is the effect of period, j = 1.....2

$P(R)_{jk}$ is the random effect of period within replication, considered to be error I

T_i*P_j is the effect of interaction between treatments and periods

e_{ijk} is the error II

In the broiler experiment, performance was estimated based on completely Randomized Design, using the GLM procedure of SAS (SAS, 1988). Differences among means were detected using Duncan Multiple Range Test (SAS, 1988).

The mathematical model was:

$Y_{ij} = \text{Ц} + T_i + e_{ij}$

Where:

Y_{ij} is the effect of $_i$th treatment on $_j$th pen

Ц is the overall mean

T_i is the effect of treatment, i = 1......5

e_{ij} is the error term

Differences among the means were detected using the Duncan Multiple Range Test as described in Steel and Toori (1980).

The time schedule and phases of the srudies are presented in Table 7.

Table 7. Time schedule and phasing of the project pertaining to the birds and feeding

	Months of the study																							
Activities of the project	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	10	11	12	13	14	15	16	17	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Preparation of the chicken house, buying materials canola plantation	**Phase I**																							
Starting growing period , Canola plantation					**Phase II**																			
Layer experiment starts, data will be obtained monthly, weekly & daily										**Phase III**														
Analysis of the layer data and writing report Canola plantation																**Phase V**								
Broiler experiment starts, analysis of the data , writing final report																			**Phase VI**					

5. Results and Discussion
5.1. Chemical analysis

The chemical analysis of the canola used in this study was presented in Table (8)

Table 8. The Chemical and Amino Acids analysis of Canola seeds

Nutrients	Canola in this study	Canola in other studies	Reference	Corn[1]	SBM[1]
Moisture, %	4.62	7.17	Nwokolo& Sim, 1989	11.00	11.00
Crude Protein, %	25.58	22.0	Leeson & Summers, 1991	8.50	44.0
Ether Extract, %	38.18	40.0	Leeson & Summers, 1991	3.80	0.80
Crude Fiber, %	6.84	6.0	Leeson & Summers, 1991	2.20	7.0
Ash, %	4.00	3.86	Nwokolo & Sim, 1989	NA	NA
ME, kcal/kg	4128[2]	4460	Lee *et al.*, 1995	3350	2230
Aspartic Acid, %	1.78	NA	Leeson & Summers, 1991	NA	NA
Serine, %	1.11	NA	Leeson & Summers, 1991	0.37	2.29
Glutamic Acid, %	5.24	NA	Leeson & Summers, 1991	NA	NA
Glycine, %	1.26	NA	Leeson & Summers, 1991	0.33	1.90
Alanine, %	1.10	NA	Leeson & Summers, 1991	NA	NA
Valine, %	1.19	NA	Leeson & Summers, 1991	0.40	2.07
Methionine, %	0.54	0.5	Leeson & Summers, 1991	0.18	0.62
Isoleucine,%	0.94	0.8	Leeson & Summers, 1991	0.29	1.96
Leucine, %	1.67	1.6	Leeson & Summers, 1991	1.00	3.39
Tyrosine, %	0.63	0.5	Leeson & Summers, 1991	0.30	1.91
Phenylalanine, %	1.06	0.9	Leeson & Summers, 1991	0.38	2.16
Histidine, %	0.68	0.6	Leeson & Summers, 1991	0.23	1.17
Lysine, %	1.66	1.3	Leeson & Summers, 1991	0.26	2.69
Arginine, %	1.13	1.3	Leeson & Summers, 1991	0.38	3.14
Therionine, %	1.11	1.0	Leeson & Summers, 1991	0.29	1.72
Salt as NaCl, %	0.18	0.04	Leeson & Summers, 1991	0.06	0.07
Calcium,%	0.38	0.38	Leeson & Summers, 1991	0.02	0.29
Av. Phosphorus, %	0.74*[1]	0.47	Leeson & Summers, 1991	0.08	0.27
Potassium, %	0.71	0.81	Leeson & Summers, 1991	0.30	1.98
Sodium, %	0.02	0.01	Leeson & Summers, 1991	0.02	0.02
Magnesium, %	0.32	0.31	Leeson & Summers, 1991	0.12	0.30
Manganese, mg/kg	37.40	35	Leeson & Summers, 1991	7.00	43.0
Copper, mg/Kg	6.97	6	Leeson & Summers, 1991	3.00	15.0
Zinc, mg/Kg	50.65	26	Leeson & Summers, 1991	18.00	55.0
Iron, mg/Kg	92.39	0.02*[2]	Leeson & Summers, 1991	45.00	170.0

[1]NRC, National Research Council, 1994

[2]ME was calculated from the determined TME using the correction factor (1.097) as reported in "Scott *et al.*, 1982".

Italic = Non-essential amino acids, Bold = Essential amino acids, NA, Not Available, *[1] = total *[2] = %

It is obvious from the table that the dry matter content of the canola used in this study was higher than the ones reported in other studies and that has contributed to the higher protein, fiber and ash content of the canola. Fat content, on the other hand, was lower which resulted in a lower metabolizable energy as compared with the study of Lee *et al.* (1995). Nevertheless, the energy content of the canola was much higher than that of the corn or SBM (NRC, 1994). On the other hand, the protein level of the canola was much higher than that of the corn and much lower than that of the SBM (Leeson and Summers, 1991).

Most of the amino acids level of this canola was in a close proximity to those reported by others (Leeson and Summers, 1991). However, lysine, the second most limiting amino acid was conceivably higher than other studies. This indeed would compensate the lower lysine content of corn. Methionine, the first limiting amino acid, was comparable to that of the SBM (Leeson and Summers, 1991 and NRC, 1994). Calcium and Phosphorus levels were higher in the canola compared to that of the SBM and Corn (NRC, 1991).

In general, with exception of protein level, canola seeds are very much similar to the SBM in so many aspects and if the trial would prove the success of using it in the birds rations then, recommendation can be justified.

5.2. Layer Experiment

During the last few years, interest in using canola seeds in the poultry diet has sharply been increased in the countries of the northern hemisphere such as Canada where oil extracted from these seeds is vastly performed. However, full-fat canola seeds are not normally used as feedstuff for poultry. But with it's high content of energy (42 % fat and 21 % protein) (Nwokolo and Sim, 1989) it could be a good alternative to corn or soybean if economically priced. These seeds have never been planted or used in Saudi Arabia till lately when King Faisal University in Al-hofuf, represented by the Department of Crop Sciences have successfully planted these seeds in large quantities. Having this in mind, two experiments were conducted in an attempt to use locally grown full-fat canola seeds (LGFFCS) in the diets of broilers and laying hens.

The results of the layer experiment was presented in tables (9 and 10)

The duration of this study continued for two seasons, fall and summer, therefore, season of the year was considered as a factor, which might interact with the canola level to affect performance.

Effect of dietary treatments on feed consumption and conversion was significant ($P<0.05$). This effect was interacted by season on this trait (highly significant interaction in case of feed conversion and significant at 10 % in case of feed consumption.

Since feed consumption was not significantly ($P>0.05$) affected by the interaction with season therefore a significant independent effect of the treatment was demonstrated by the higher consumption of the birds fed higher levels of canola seeds in the diet. However the differences were not significant ($P>0.05$) between the control and, 5 and 10 % canola seeds. Higher levels of the seeds may impose a palatability problem. Leslie and Summers (1972) and Summers *et al*., (1982) and Clement and Kenner (1977) reported lower feed consumption when 15 – 17 % canola seeds were used in the layer diet. This lower consumption could be due to the lower amount of fine feed in the ration (Leeson *et al*., 1987) explained. To the contrary, Shen *et al*. (1983) used up to 20 % of full-fat canola and found it to be acceptable. In the same line, Summers *et al*. (1982) observed increased consumption in birds fed increased canola seeds.

Regardless of treatments, feed intake in this study was highly (P<0.01) affected by season of the year. This phenomenon is known for some time. Scott *et al*. (1982) reported higher consumption in the winter opposing summer time. Tannor *et al*. (1984) reported lower consumption of individual birds with heat stress.

Feed conversion, egg weight, egg production and egg mass were significantly (P<0.05) affected by (season X diet) interaction (Table 9). Feed conversion was higher in birds fed higher levels of canola seeds (20 and 30 %) in both seasons. The best feed conversion was found in birds fed 5 and 10 % canola seeds. This of course was due to the better egg mass of summer and winter birds receiving 5 % canola seeds.

The negative effect of adding 30 % canola seeds in the summer birds was less pronounced than in those raised in the winter time (79 vs 68 %, production). This could be due to the fact that canola seeds contain high level of fat (42 %), (Nwokolo and Sim, 1989) and also to the fact that fat produce lower heat increment than either CHO or protein (Scott *et al*., 1982) which probably put less burden on birds during the hot season consequently producing more eggs.

Egg weight was significantly affected by the interaction between diet and period of the year. Increasing level of canola seeds in both seasons significantly (P<0.05) decreased egg weight (Table 9). Fat content of the yolk is a major factor to determine the size of the egg. Study by Leeson *et al*. (1987) and by others suggested that chicken might not make maximum utilization of the fat provided by the full-fat canola seeds. Birds fed diet fortified with 20 % full-fat canola retained only about 50 % of the dietary fat, they further added. It was assumed that formation of insoluble soaps involving fatty acids and minerals could lead to reduced retention (Hakansson, 1975; Sibbald and Price, 1977; Kussaibati *et al.*, 1983; Atteh and Leeson, 1983, 1984). In our case, the small amount of erucic acid in the canola seeds could be the fatty acid that formed soap with minerals.

Best production rate was found in birds fed 5 % in both summer and winter seasons (84.2 and 91.6 %), (Table 9). The depression in performance of hens fed 20 and 30 % full-fat canola seeds could be due to the presence of low levels of glucosinolates in canola seeds. Bell and Weaver (2002) reported that when canola meal was fed in levels higher than 5 % could cause liver degeneration, thyroid hypertrophy, reduced feed efficiency and loss of egg production as they contain high level of glucosinolates and erucic acid. Canola seeds (00), used in this study were not tested for such compounds but it was assumed to have very low erucic acid and glucosinolates (less than 2%) (Leela *et al*., 2002). Nwokolo and Sim (1989) drew similar conclusion on hens fed raw full-fat canola seeds.

Birds fed high levels of locally grown full-fat canola seeds (LGFFCS) in this experiment produced smaller eggs in both seasons (Table 9). The differences were significant ($P<0.05$) and mostly relative to the treatments and some to the seasons.

Egg mass is a function of egg weight and egg production and was probably affected by any changes occurred on either of them. Lower egg mass was found in birds fed 10 and 20 % LGFFCS. Similar picture was seen in hen-day egg production and egg weight (Table 9).

Mortality was not affected by treatment/season interaction or by either of them independently (Table 9 & 10). Because of the low mortality, diagnosis was not done on the dead birds. Leslie and Summers (1972) observed no differences in mortality when feeding diets fortified with canola seeds.

Although higher feed intake was obtained with the high levels of canola seeds (20 and 30 %), a significant ($P<0.001$) depression of weight gain was observed in the birds fed 20 and 30 % (Table 10). This would not be very much surprising if most of the feed was used to produce more and larger eggs. However, that was not the case in this study. Lower egg weight and production rate were found in the birds fed these diets. It is conceivable that toxicity from the erucic acid and glucosinolates could have been the reason for the weight depression in these birds. It was also noticed that in feces of birds fed higher levels of FFCS, higher levels of these seeds passed the intestine undigested which means lower nutrients were utilized by the birds, fed those diets and consequently lower performance and birds weight. Summers *et al*. (1982) reported lower body weight gain when 17.5 % full-fat canola seeds were used in broiler diets.

Effect of dietary treatments on egg characteristics was highly significant ($P<0.01$) (Table 10).

Inclusion of 30 % LGFFCS in the diets improved the specific gravity of the eggs comparing to 5 and 10 % but not to the control or 20 % (Table 10). This may seem bit peculiar and difficult to explain.

Summer birds produced better shell quality eggs. This is against the odd since normally eggs produced in the summer have less shell (Bell and Weaver, 2002). The differences in summer temperature and winter were not large enough to cause changes on shell quality (30 in the summer vs

25 in the fall). These birds were housed in a closed house with some cooling management was practiced there.

Albumen height (haugh unit) was significantly ($P<0.05$) higher in birds fed 30 % LGFFCS than the control. However, no significant differences ($P>0.05$) were observed between 30 and the rest of the treatments (Table 10).

The effect of LGFFCS levels on yolk color was highly significant ($P<0.01$) (Table 10). Darker yellow color was found in eggs of hens fed higher levels of canola seeds. As level of LGFFCS increased from 0 to 30 % there was an increasing levels of darkness of color of the yolk with strong negative linearity ($r = - 0.97$). This result was in agreement with the study of Nwokolo and Sims (1989) who observed that yolk color index was significantly increased in eggs from hens fed diets containing increasing amounts of full-fat canola seeds.

Fall birds laid eggs that have significantly darker color yolk than summer eggs (Table 10). Fall birds also consumed significantly more feed than summer birds.

Although egg size was not the smallest in hens fed 20 % LGFFCS, yolk index was the best in eggs of these birds which indicate that Albumen play a major role in making the bulk of these eggs. Fall eggs have better yolk index and in the same time larger egg size.

5.2.1. Conclusion:

There was some evidence in this experiment to conclude that adding up to 10 % LGFFCS in the layer diet cause no harm effect on performance of layers. However, adding only 5 % has significantly improved the performance of the layers comparing to the control.

It is suggested that incorporating 10 % of the full fat canola seeds in the layer diet may be beneficial to the producer of this country if economically feasible.

Table 9. Effect of incorporating different levels of Canola seeds on some traits of layers during two seasons of the year[1]

Source Of variation	GBD Gm	FC Kg/Kg	EW gm	HD %	LIV %	EM Gm/HD
P X TRT	NS	**	*	**	NS	**
Sum 0	103.2±10.9	2.38±0.60	54.81±5.3	82.28±13.0	99.86±0.76	45.25±8.75
Sum 5	102.9± 9.9	2.32±0.60	54.74±4.1	84.22±14.2	100.0±0.00	46.38±9.46
Sum 10	102.0±12.5	2.39±0.48	53.86±4.2	81.65±13.7	99.76±1.84	44.08±8.31
Sum 20	106.5±12.2	2.70±0.55	51.65±3.4	78.31±11.4	99.58±3.23	40.62±7.29
Sum 30	101.6±12.9	2.65±0.61	49.93±3.0	78.92±12.9	99.58±2.29	39.46±7.08
Fall 0	115.4±15.1	2.17±0.52	62.88±3.6	86.57±11.1	99.84±1.23	54.38±7.24
Fall 5	115.3± 7.2	2.06±0.20	61.48±2.2	91.61± 6.7	100.0±0.00	56.33±4.76
Fall 10	114.3± 7.9	2.14±0.37	61.74±1.8	87.98±10.4	100.0±0.00	54.43±6.86
Fall 20	116.8±11.4	2.92±0.66	57.94±2.0	72.10±15.3	100.0±0.00	41.26±8.91
Fall 30	120.8±12.8	3.53±1.10	55.02±2.4	67.56±18.9	100.0±0.00	37.29±10.8
P <	0.0649	0.00001	0.0318	0.0001	0.6657	0.0001
Among TRT	**	**	**	**	NS	**
0	109.3^{ab}	2.278^{c}	58.85^{a}	84.42^{b}	99.85^{a}	51.36^{a}
5	109.1^{ab}	2.192^{c}	58.11^{ab}	87.92^{a}	100.00^{a}	49.82^{a}
10	108.2^{b}	2.266^{c}	57.80^{b}	84.81^{ab}	99.88^{a}	49.26^{a}
20	111.7^{a}	2.812^{b}	54.80^{c}	75.21^{c}	99.79^{a}	41.19^{b}
30	111.2^{ab}	3.094^{a}	52.47^{d}	73.24^{c}	99.79^{a}	38.37^{c}
P <	0.0010	0.00001	0.0001	0.0001	0.6657	0.0001
Among Periods	**	NS	**	NS	NS	**
Summer	103.2^{b}	2.491^{a}	53.00^{b}	81.16^{a}	99.76^{a}	43.16^{a}
Fall	116.5^{a}	2.566^{a}	59.81^{a}	81.08^{a}	99.97^{a}	48.84^{b}
P <	0.0001	0.122	0.0001	0.9364	0.0766	0.0001

[1] Means Within columns carrying different superscripts are significantly different, P<0.05. **NS** = Not significant, P>0.05

GBD, gram per bird per day, daily feed intake; **FC**, Kg feed per Kg eggs, feed conversion; **EW**, gram egg weight; **HD,** percent hen-day production; **LIV**, percent livability; **EM**, gram per hen-day egg mass (% HD * EW)

TRT = 0, 5, 10, 20 and 30 % of Canola seeds

Table 10. Effect of incorporating different levels of Canola seeds on Some traits of layers during two seasons of the year[1]

Source Of variation	SPG	HU	YC	YI	WG
Period X TRT	NS	NS	NS	NS	
Summer 0	1.091±0.004	100.6±4.52	2.254±0.98	0.985±0.21	NA
Summer 5	1.090±0.004	102.6±4.40	2.583±0.91	1.008±0.21	NA
Summer 10	1.090±0.004	101.8±2.88	2.900±0.88	1.048±0.22	NA
Summer 20	1.092±0.003	102.0±2.78	3.567±0.98	1.178±0.23	NA
Summer 30	1.092±0.003	102.6±2.77	3.733±0.95	1.046±0.25	NA
Fall 0	1.088±0.003	101.3±3.19	2.417±1.11	1.251±0.14	NA
Fall 5	1.087±0.003	102.8±2.65	3.000±0.97	1.284±0.14	NA
Fall 10	1.087±0.003	102.8±2.57	3.300±0.91	1.344±0.12	NA
Fall 20	1.088±0.003	103.6±2.66	3.433±1.03	1.436±0.15	NA
Fall 30	1.090±0.003	104.1±2.36	3.833±1.03	1.370±0.24	NA
P <	0.0787	0.5087	0.2224	0.3469	
Among TRT	**	**	**	**	**
0	1.090^{ab}	101.0^{c}	2.336^{e}	1.118^{c}	338.2^{a}
5	1.088^{b}	102.7^{ab}	2.792^{d}	1.146^{c}	218.6^{ab}
10	1.088^{b}	102.3^{b}	3.100^{c}	1.200^{b}	118.2^{bc}
20	1.090^{ab}	102.8^{ab}	3.500^{b}	1.307^{a}	40.6^{c}
30	1.091^{a}	103.4^{a}	3.783^{a}	1.208^{b}	35.2^{c}
P <	0.0001	0.0001	0.0001	0.0001	0.0001
Among Periods	**	**	*	**	
Summer	1.091^{a}	101.9^{a}	3.010^{a}	1.053^{a}	NA
Fall	1.088^{b}	102.9^{b}	3.200^{b}	1.337^{b}	NA
P <	0.0001	0.0001	0.0183	0.0001	NA

[1] Means Within columns carrying different superscripts are significantly different, P<0.05. **NS** = Not significant, P>0.05

SPG, specific gravity of the egg; **HU**, haugh unit; **YC**, Yolk color (graded from 1 to 5 where 5 is the darkest); **YI,** yolk index (yolk height ÷ yolk diameter); **WG,** weights of the birds were taken twice, one at the beginning of the experiment and again at the end of it. **Weight gain** was determined according to that . **TRT** = 0, 5, 10, 20 and 30 % of Canola seeds; **NA**, Not available

5.2.2. References

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5.3. Broiler Experiment:

The weekly performance of the broilers was presented in Tables 11 and 12. These tables exhibited the actual performance of the birds calculated on weekly basis. This may be of an interest to the researcher since they aim to discuss the changes in birds each week. However that is not the case in the producer's mind. They only look at performance of the birds at the market age since this age will determine their profitability.

This experiment lasted for 6 weeks as traits like weekly gain, weekly feed intake, weekly livability and weekly feed conversion were considered in this study.

Four levels of canola seeds; 5, 10, 20, 30 % and a control (0 %) were fed either whole or ground to 360 broiler chicks starting day 1 and continued for 6 weeks. The process of grinding was done in an attempt to facilitate the use of canola by young chicks. Layer experiment, reported in this manuscript, showed some difficulties in utilizing whole canola by mature birds.

Since there were two types of treatments; level of canola and form of canola, interaction between the two was possible. If the interaction was significant then effect of treatment level or form was nullified in both weekly and cumulative performance.

Weight gain was significantly ($P<0.05$) affected by the interaction in weeks 3 and 5 (Table 11). However, the effect of each factor independently was clearly demonstrated by the significant differences in all the weeks of the experiment (Table 12). This strong effect was due to the weak performance of the birds fed 30 % canola seeds, in most cases. Weight gain of the birds under this treatment was the lowest in all weeks except week 6. This can be explained by the fact that all birds under this treatment died except 2, which probably had higher weights (Table 12).

In normal broiler flock, weight gain usually reach plateau in about week 5 or 6 and then decline (North 1984). In this experiment, birds fed 5 % whole canola had the highest gain in weeks 4 and 5 while those fed 30 % ground canola had the lowest gain in these weeks (Table 12).

It is obvious that grinding had negatively affected the performance of the birds. Regardless of canola level, grinding, lowered significantly ($P<0,0001$) the performance of the broilers in all the weeks of the experiment (Table 12). This result contradicted what we had anticipated and what the previous research had shown. It was assumed that grinding the seeds would break the hard walls of the seeds availing the inside materials to gastric juices. Clark *et al*. (2001) reported improved amino acid digestibility, weight gain and feed conversion when canola seed shells were removed before feeding.

Feed intake was significantly ($P<0.05$) affected by the interaction in weeks 3 and 6 (Table 11). In all cases, feed intake was lower when high level ground canola feed was fed to the birds, which in turn affected the performance of the birds. This was better presented in table 12. Regardless of canola level, the negative effect of grinding was evident in all weeks of the experiment with highly significant differences ($P<0.05$) in weeks 1, 3, 5 and 6.

It was observed that young chicks refused to eat the canola seeds and that was proportional to the level of canola seeds in the diet. (Pictures 1 – 6 showing the deprived amount of canola seeds by the young chicks as level of canola increased from 5 to 30 %). Whether the color of the seeds or palatability was the reason for this rejection is open for discussion.

Summers *et al*. (1982) attempted to die the diet containing high level of full-fat canola seeds with artificial color and fed it to the birds. They observed improved performance with increased feed consumption of diet high in canola seeds. The rejection in this experiment involved both ground and whole canola, which explains that rejection, was not only due to color but could be to flavor too. Chicks were never overcame this problem during the weeks of the experiment and the consumption remained low to the end of the experiment.

As mentioned previously, consumption of the birds, fed whole canola was better than those fed ground ones. Incidentally, feces of the birds fed the whole canola had more undigested seeds than those had the ground canola.

Pic 7. Pictures above and below show broiler chicks, fed 30 % canola seeds, avoiding the feed

Pic. 8. Broiler chicks, fed 20 % canola seeds

Pic. 9. Broiler feed contain 10 % canola seeds

Pic 10. Broiler chicks eating feed contain 5 % canola

Pic 11. The control feed (no canola seeds)

Treatment levels as well as form of canola affected weekly livability in weeks 5 and 6. Birds fed 30 % ground canola seeds had the lowest livability.

Weekly feed conversion as measured by kilogram feed per kilogram live weight was also affected by level of canola in weeks 1, 2, 3, 4 and 5 and by forms of canola in weeks 4, 5, and 6 (Table 12). In almost all the cases worst conversion occurred in birds fed 30 % whole canola and better ones in those either fed no or 5 % canola seeds.

Between forms of canola, the effect of grinding was significant ($P<0.05$) in weeks 4, 5 and 6 with birds fed whole canola had better feed conversion (Table 12).

It was not possible to obtain normal data from birds fed 30 % ground canola in week 6. Most of these birds died in this week.

The cumulative performance of the broilers fed different levels of canola was presented in tables 13 & 14. Since all performance data have accumulated in week 6, therefore discussion will be focused on that week.

Interaction between level and form of canola was not significant ($P>0.05$) in all the traits measured in week 6.

Feeding 20 and 30 % canola seeds significantly ($P<0.0001$) depressed final body weight (Tables 13 & 14). This result was in line with those reported by Leeson *et al.* (1987); Leslie and Summers (1972); Clement and Renner (1977) and Summers *et al.* (1982) who showed a decreased feed consumption and weight gain with increasing level of canola seeds in the diet while, Coetze *et al.* (2001) reported no such effect on weight gain or feed consumption. Summers *et al*. (1982) assumed that high level of fat in the canola was responsible for the lower digestibility in the birds and consequently lower performance. Level of fat in the canola was higher that that of corn or soybean meal.

The effect of grinding was evident on body weight with significantly ($P<0.05$) lower body weight of the birds in week 6 (Table 14). Similar lower feed consumption was observed in birds fed ground canola, which probably participated in reducing growth of the birds (Table 14).

Feed intake of this experiment, although was not significantly affected by level of canola in week 6, the consumption was in general lower than normal, even with control. It is possible that the fish meal used in feed was of lower quality. Diet of the control birds had relatively more fish meal than other treatments (Tables 4 & 5)

Data of final body weight in week 6 were extrapolated against level of canola seeds. It was clear that body weight was negatively correlated with level of canola seeds. Increasing level of canola from 0 to 30 % decreased live weight ($r = -0.896$) with one exception. Inclusion of 5 % canola seeds improved final weight of the birds. Much of this improvement was attributed to the whole form of canola (Table 13). Differences among 0, 5 and 10 % were not significant pertaining to final body weight (Table 14). Mateo *et al.* (1999) found a decrease in body weight with each increment of canola meal in starter feed and the best improvement seen in performance was with 10 % canola meal with electrolyte balance adjustment. Leeson *et al*. (1987) and Shen *et al*. (1983) stated that full fat canola seeds can be a good source of energy if used in 10 about % level of the broiler diet.

Feed conversion on the other hand followed similar trend to body weight and feed intake (Table 14). Best feed conversion was achieved with birds fed 0 and 5 % canola seeds. The worst feed conversion was found in birds fed 30 % canola seeds (Table 14).

The cumulative mortality rate of the birds was very high in birds fed 30 % canola (Table 14). Over the six weeks almost half of the birds died at which some pens were empty at week 6. Post mortem examination revealed no abnormalities in the organs of the dead birds. Whether toxicity from glucosinolate, erucic acid or starvation are open for speculation. As previously mentioned, the canola used in this study (Bactool) were of 00 type which refer to a very low erucic acid (< 2 %) and very low to zero level of glucosinolate (Leela *et. al*., 2001).

Shele *et al*. (1992) and Newkirk and Classen (2002) provided some evidence that some kind of heart problems occurred in birds fed canola seeds and may that be due to the presence of high level of serum T3 which in turn increased the metabolic rate of the body. This would increase the need for more O^2 and that could have been limited in the house.

Although the differences were not significant between types of the seeds, grinding exacerbated the problem of mortality (Table 14).

Data of dressing analysis revealed no significant interaction between level and sex, level and form and form with sex pertaining to dressing % and fat % (Table 15).

Independently, the effects of canola level, form of canola and sex of the bird on dressing parameter were not significant ($P>0.05$) related to dressing % and fat %. However, inclusion of 30 % canola in the diet significantly ($P<0.05$) decreased fat weight (Table 16). Franzoi *et al*. (2000) found a linear decrease in dressed weight with the amount of canola meal used in the broiler diets. The percentage of carcass fat remained unchanged with inclusion of canola meal. They further added.

Numerically (non significantly), higher dressing % was found in birds fed 10 % canola seeds. However, more fat was found in those fed 5 % canola (Table 16).

The effect of canola form was significant on fat level of the birds, calculated on live weight basis. More fat was observed in birds fed whole canola seeds. Between sexes, male birds had higher dressing % and less fat than females.

The negative effect of high canola in this experiment was more pronounced in chicks than older birds. Summers *et al.* (1982) believed that palatability of the young chicks could be the reason for early bad performance. Leeson *et al.* (1987) showed that metabolizable energy of the diet was less with higher canola level and palatability was negatively affected with increasing level of canola and there was no sign of selectivity or rejecting the ground feed by the young chicks. They believed that the detrimental effect of high dietary amounts of full-fat canola was associated with a decrease in feed intake and an inability to retain dietary fat.

Due to the above effect canola was subjected to some treatments prior to feeding such as toasting. The process of toasting canola lowered the content of glucosinolate in the meal and helped removing some of the toxic materials that caused depression.

Grinding was also used in attempt to improve the performance of the chicks. Shen (1983) showed that if the seeds were finely ground or if the seeds were steam pelleted in order to rupture the coat, good results with up to 20 % whole canola seeds could be expected. In this study, grinding the canola caused lower performance in the chicks.

Based on the results of this experiment and those reported by others that type or form of canola or method of processing or others related to canola may not be the sole reason for the lower performance of the broilers. It is believed that age of the birds play an important role affecting the performance of the broilers. Therefore another experiment is under investigation to determine if feeding full fat canola seeds to older birds may prove otherwise.

5.3.1. Conclusion:

Under the circumstances of the broiler experiment and upon the results obtained it is concluded that feeding full fat canola seeds either as whole seed or ground may be harmful for broiler chicks. However, there were some indications that adding 5 % canola seeds may not be as bad as it looks. Therefore, more experiments are needed to determine the validity of using canola with broilers and if that happen then in what age.

Table 11 . Effect of interaction between level and form of canola on weekly performance of broilers birds[1]

Traits	Level X form	Weeks in experiment					
		1	2	3	4	5	6
Weekly weight Gain, gm	0	76.5± 3.9	198.2±11.0	254.5±33.2	244.0±30.2	153.5±48.1	114.0±66.5
	5 W	77.2± 7.5	182.5±12.8	246.8± 4.5	296.8±32.9	335.2±49.9	287.0±99.3
	5 G	74.8± 0.5	183.0±12.9	238.8±13.9	222.2±45.2	175.2±22.9	112.7±54.4
	10 W	70.8± 4.6	187.8±15.2	235.5±23.0	258.0±47.4	270.8±38.5	292.0±97.0
	10 G	68.5± 6.2	172.8±10.9	224.8±19.8	196.5±40.6	134.0±12.5	87.0±63.2
	20 W	76.8± 4.8	171.8±16.1	207.2±20.2	238.2±33.2	202.0±44.6	108.3±41.9
	20 G	70.2± 6.1	156.5±12.9	189.8±22.2	177.2± 8.1	127.0±19.2	76.5±29.5
	30 W	62.5±10.9	163.2± 6.7	210.5±37.8	162.0±20.7	122.2±29.2	117.0±35.4
	30 G	53.0± 7.5	128.5± 6.9	136.8±15.8	120.2±28.1	79.8±36.3	NA
	P > F	**0.6252**	**0.0561**	**0.0258**	**0.8372**	**0.0100**	**0.0676**
Weekly feed intake, gm	0	84.8± 5.7	321.5±17.9	386.2± 4.9	478.5± 21.5	456.0± 61.6	364.4±121.1
	5 W	86.0± 9.8	328.8±13.2	366.8±13.1	549.0± 82.7	699.5± 74.1	695.8± 67.9
	5 G	83.2± 8.1	331.8±36.7	348.5±14.8	521.0±119.3	493.7± 68.0	458.4± 80.3
	10 W	81.8± 6.7	297.5±22.3	368.2±22.2	622.5± 94.9	635.5±116.9	715.4±101.4
	10 G	77.5± 9.2	318.5±30.6	341.8±25.5	460.2± 61.1	433.0±35.2	401.2±107.7
	20 W	99.5±22.2	362.0±37.3	387.5±50.9	563.5± 67.4	521.0±123.5	425.7±95.9
	20 G	84.8± 6.2	325.2±26.1	340.5±19.2	536.0±104.2	439.7± 58.7	384.0±73.8
	30 W	89.8± 4.6	352.5±48.1	380.0±42.4	572.3± 11.0	393.7±144.6	484.8±25.6
	30 G	73.8±6.2	303.2± 4.1	346.5±27.2	588.5± 37.7	521.0±123.5	NA
	P > F	**0.4366**	**0.0769**	**0.0038**	**0.1456**	**0.4591**	**0.0259**
Weekly Livability, %	0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	98.2±3.6	100.0±0.0
	5 W	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0
	5 G	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	96.4±4.6	95.0±7.2
	10 W	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	97.6±3.0
	10 G	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	98.4±3.2	99.1±1.8
	20 W	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0
	20 G	100.0±0.0	100.0±0.0	100.0±0.0	99.2±1.6	96.4±4.1	95.4±3.8
	30 W	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	94.8±3.9	90.5±0.0
	30 G	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	94.7±4.4	NA
	P > F	**NA**	**NA**	**NA**	**0.3789**	**0.6515**	**0.1458**
Weekly feed conversion, Kg/Kg	O	1.107±0.02	1.62±0.11	1.54±0.22	1.97±0.15	3.14±0.7	114.0±66.5
	5 W	1.114±0.08	1.81±0.09	1.49±0.04	1.86±0.24	2.10±0.1	287.0±99.3
	5 G	1.114±0.11	1.85±0.27	1.46±0.07	2.34±0.22	2.82±0.1	112.7±54.4
	10 W	1.155±0.03	2.08±0.15	1.57±0.10	2.43±0.25	2.35±0.3	292.0±97.0
	10 G	1.130±0.05	2.36±0.11	1.53±0.13	2.39±0.35	3.25±0.3	87.0±63.2
	20 W	1.287±0.20	1.81±0.10	1.87±0.12	2.38±0.25	2.59±0.2	108.3±41.9
	20 G	1.210±0.09	1.59±0.10	1.81±0.15	3.04±0.66	3.47±0.1	76.5±29.5
	30 W	1.474±0.30	2.36±0.11	1.86±0.43	3.58±0.50	4.34±1.1	117.0±35.4
	30 G	1.417±0.25	2.17±0.36	2.55±0.23	5.17±1.56	5.26±1.8	NA
	P >	**0.9635**	**0.4278**	**0.0016**	**0.1188**	**0.9931**	**0.4338**

[1] Means that are not carrying the same superscripts are significantly different, P<0.05

Table 12 . Weekly performance of broilers fed different levels of Canola seeds[1]

Traits	Canola Level, %	Weeks in experiment					
		1	2	3	4	5	6
Weekly weight Gain, Gm		**Among levels of Canola**					
	0	76.5 0^{a}	198.25^{a}	254.5^{a}	244.0^{ab}	153.5^{c}	114.0^{ab}
	5	76.00^{a}	182.75^{b}	242.8^{a}	259.5^{a}	255.2^{a}	212.3^{a}
	10	69.62^{a}	180.25^{b}	230.1^{a}	227.2^{ab}	202.4^{b}	189.5^{ab}
	20	73.50^{a}	164.12^{c}	198.5^{b}	207.8^{b}	164.5^{bc}	90.1^{b}
	30	57.75^{b}	145.88^{d}	173.6^{b}	138.1^{c}	101.0^{d}	117.0^{ab}
	P >	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0095**
		Between forms of Canola					
	W	72.75^{a}	180.7^{a}	230.9^{a}	243.9^{a}	216.8^{a}	206.9^{a}
	G	66.62^{b}	160.2^{b}	197.5^{b}	179.1^{b}	129.0^{b}	90.2^{b}
	P >	**0.0294**	**0.0008**	**0.0023**	**0.0001**	**0.0001**	**0.0002**
weekly livability, %		**Among levels of Canola**					
	0	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}	98.22^{ab}	100.0^{a}
	5	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}	98.22^{ab}	98.2^{a}
	10	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}	99.21^{a}	98.4^{a}
	20	100.0^{a}	100.0^{a}	100.0^{a}	99.6^{a}	98.22^{ab}	97.4^{a}
	30	100.0^{a}	100.0^{a}	100.0^{a}	100^{a}	94.77^{b}	90.5^{b}
	P >	NA	NA	NA	**0.5346**	**0.1000**	**0.0305**
		Between forms of canola					
	W	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}	98.60^{a}	98.1^{a}
	G	100.0^{a}	100.0^{a}	100.0^{a}	99.8^{a}	96.50^{a}	96.9^{a}
	P >	**NA**	**NA**	**NA**	**0.3172**	**0.0671**	**0.0939**
weekly feed intake, gm		**Among levels of Canola**					
	0	84.75^{a}	406.2^{ab}	386.2^{a}	478.5^{a}	456.0^{b}	364.4^{b}
	5	84.62^{a}	414.9^{ab}	357.6^{a}	535.0^{ab}	596.6^{a}	594.0^{a}
	10	79.62^{a}	387.6^{b}	355.0^{a}	541.4^{ab}	534.2^{ab}	558.3^{a}
	20	92.12^{a}	435.8^{a}	364.0^{a}	549.8^{ab}	480.4^{b}	401.9^{b}
	30	81.75^{a}	409.6^{ab}	363.2^{a}	581.6^{b}	454.0^{b}	484.8^{ab}
	P >	**0.1362**	**0.1810**	**0.9003**	**0.2028**	**0.0063**	**0.0007**
		Between forms of canola					
	W	88.35^{a}	332.4^{a}	377.8^{a}	556.4^{a}	565.3^{a}	574.7^{a}
	G	79.81^{a}	319.7^{a}	344.3^{b}	526.4^{a}	440.0^{b}	410.5^{b}
	P >	**0.0134**	**0.1453**	**0.0038**	**0.0807**	**0.0001**	**0.0001**
weekly feed conversion, Kg/Kg		**Among levels of Canola**					
	0	1.107^{a}	1.624^{b}	1.540^{c}	1.975^{a}	3.14^{b}	3.488^{a}
	5	1.114^{a}	1.808^{b}	1.474^{c}	2.101^{a}	2.46^{b}	3.410^{a}
	10	1.142^{a}	1.721^{b}	1.548^{c}	2.409^{a}	2.80^{b}	4.135^{a}
	20	1.248^{a}	2.106^{a}	1.836^{b}	2.710^{a}	3.03^{b}	4.855^{a}
	30	1.445^{b}	2.266^{a}	2.204^{a}	4.486^{b}	4.80^{a}	4.312^{a}
	P >	**0.0012**	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.3793**
		Between forms of canola					
	W	1.22^{a}	1.863^{a}	1.665^{a}	2.384^{a}	2.903^{b}	3.238^{b}
	G	1.22^{a}	2.028^{b}	1.836^{b}	3.235^{b}	3.698^{a}	5.268^{a}
	P >	**0.4830**	**0.1836**	**0.0583**	**0.006**	**0.0043**	**0.0017**

[1] Means that are not carrying the same superscripts are significantly different, $P<0.05$

Table 13. Effect of interaction between level and form of canola on cumulative performance of broiler birds[1]

Traits	Canola level/ form	Weeks in experiment					
		1	**2**	**3**	**4**	**5**	**6**
Cumulative Livability, %	**0**	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	093.6±12.8	90.0±14.1
	5 W	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0± 0.0	100.0±0.0
	5 G	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	91.8± 9.6	90.0±17.3
	10 W	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	92.8± 8.3
	10 G	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	96.1±7.9	91.8±10.8
	20 W	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0
	20 G	100.0±0.0	100.0±0.0	100.0±0.0	96.8±6.43	87.1±14.8	76.8±20.4
	30 W	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	83.2±12.6	67.9±19.2
	30 G	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	83.2±13.0	NA
	P >	**NA**	**NA**	**NA**	**0.3789**	**0.5991**	**0.2782**
Final body weight , gm	**0**	114.8± 4.3	313.0±11.4	567.5±34.0	811.5±49.3	965.0±75.8	1143.5± 77.1
	5 W	115.8± 7.6	298.2±20.1	545.0±23.8	841.8±45.4	1177.0±93.9	1464.0±187.0
	5 G	113.2± 0.9	296.2±13.0	535.0±25.2	757.2±63.0	932.5±85.2	1068.7±138.1
	10 W	109.2± 4.9	297.0±15.6	532.5±37.7	790.5±79.3	1061.2±108.3	1353.2±201.2
	10 G	107.5± 6.1	280.2±15.8	505.0±26.4	701.5±66.0	835.5± 69.8	922.5±100.9
	20 W	116.0± 4.5	287.8±13.9	495.0±31.1	733.2±62.2	935.2±105.6	1012.7±132.4
	20 G	108.8± 6.3	265.2± 7.8	455.0±26.4	632.2±27.8	759.2± 29.6	835.8± 51.5
	30 W	101.2±11.0	264.5±14.6	475.0±26.4	625.3±35.1	728.8± 42.3	827.5± 27.6
	30 G	92.2± 7.3	220.8±13.5	357.5±28.7	477.8±43.2	557.5± 46.3	NA
	P >	**0.6158**	**0.0520**	**0.0054**	**0.6921**	**0.7277**	**0.2009**
Cumulative feed intake, gm	**0**	84.8±5.7	406.2±23.5	792.5±26.9	1271.0± 15.2	1727.0± 71.0	2144.5±118.1
	5 W	86.0±9.8	414.8±22.2	781.5±32.3	1330.5±111.8	2030.0±157.7	2725.8±217.4
	5 G	83.2±8.0	415.0±44.4	763.5±50.8	1284.5±154.8	1778.2±221.0	2277.0±330.8
	10 W	81.8±6.7	379.2±28.3	747.5±47.3	1370.0±139.0	2005.5±235.6	2720.9±316.1
	10 G	77.5±9.2	396.0±24.5	737.8±31.6	1198.0± 86.4	1631.0±119.4	2032.2±181.6
	20 W	99.5±22.2	461.5±58.7	849.0±99.8	1412.5±144.1	1933.5±260.5	2258.3±297.7
	20 G	84.8±2.2	410.0±29.8	750.5±25.5	1286.6±103.8	1726.2±139.9	2110.2±155.6
	30 W	89.8±4.6	442.2±52.1	822.2±86.8	1422.0± 83.6	1887.8±196.5	2278.2±238.2
	30 G	73.8±6.2	377.0± 3.5	723.5±26.6	1312.0± 59.2	1705.7±191.4	NA
	P >	**0.4366**	**0.0845**	**0.2039**	**0.7149**	**0.7390**	**0.1343**
Cumulative feed Conversion, Kg/Kg	**0**	0.74±0.02	1.30±0.07	1.402±0.12	1.571±0.11	1.795±0.10	1.876±0.02
	5 W	0.74±0.05	1.39±0.06	1.434±0.03	1.580±0.09	1.726±0.06	1.872±0.12
	5 G	0.74±0.07	1.40±0.10	1.426±0.04	1.694±0.10	1.904±0.10	2.130±0.15
	10 W	0.75±0.03	1.28±0.06	1.406±0.07	1.736±0.11	1.888±0.04	2.018±0.08
	10 G	0.72±0.05	1.42±0.15	1.462±0.03	1.712±0.11	1.956±0.12	2.208±0.11
	20 W	0.85±0.15	1.61±0.25	1.716±0.19	1.927±0.11	2.066±0.12	2.231±0.06
	20 G	0.78±0.05	1.54±0.08	1.652±0.08	2.042±0.24	2.276±0.21	2.528±0.16
	30 W	0.90±0.12	1.68±0.22	1.737±0.25	2.275±0.09	2.586±0.15	2.750±0.20
	30 G	0.80±0.11	1.71±0.12	2.032±0.15	2.762±0.27	3.061±0.24	NA
	P >	**0.7461**	**0.5208**	**0.0384**	**0.0238**	**0.0478**	**0.6942**

[1] Means that are not carrying the same superscripts are significantly , P<0.05 different, P<0.05

Table 14. Cumulative performance of broilers fed different levels of Canola seeds[1]

Traits	Canola Level, %	Weeks in experiment					
		1	2	3	4	5	6
Final Body weight, gm	**Among levels of Canola**						
	0	114.8^{a}	313.0^{a}	567.5^{a}	811.5^{a}	965.0^{b}	1143.5^{a}
	5	114.5^{a}	297.2^{ab}	540.0^{ab}	799.5^{a}	1054.8^{a}	1294.6^{a}
	10	108.4^{a}	288.6^{bc}	518.8^{b}	746.0^{a}	948.4^{b}	1137.9^{a}
	20	112.4^{a}	276.5^{c}	475.0^{c}	682.8^{b}	847.2^{c}	911.6^{b}
	30	96.8^{b}	242.6^{d}	416.2^{d}	541.0^{c}	643.1^{d}	827.5^{b}
	P >	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0002**
	Between forms of canola						
	W	111.4^{a}	292.1^{a}	523.0^{a}	767.6^{a}	973.4^{a}	1216.6^{a}
	G	105.4^{b}	265.6^{b}	463.1^{b}	642.2^{b}	771.2^{b}	930.82^{b}
	P >	**0.0328**	**0.0003**	**0.0001**	**0.0001**	**0.0001**	**0.0001**
Cumulative livability, %	**Among levels of Canola**						
	0	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}	93.57^{ab}	90.00^{a}
	5	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}	95.89^{a}	95.71^{a}
	10	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}	98.04^{a}	92.32^{a}
	20	100.0^{a}	100.0^{a}	100.0^{a}	98.39^{a}	93.57^{ab}	86.73^{ab}
	30	100.0^{a}	100.0^{a}	100.0^{a}	100.0	83.22^{b}	67.86^{b}
	P >	**NA**	**NA**	**NA**	**0.5346**	**0.0504**	**0.0730**
	Between canola forms						
	W	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}	95.4^{a}	92.48^{a}
	G	100.0^{a}	100.0^{a}	100.0^{a}	99.2^{a}	89.6^{a}	85.84^{a}
	P >	**NA**	**NA**	**NA**	**0.3172**	**0.0833**	**0.0536**
Cumulative feed intake, gm	**Among levels of Canola**						
	0	84.75^{a}	406.2^{ab}	792.5^{a}	1271.0^{a}	1727.0^{a}	2144.5^{a}
	5	84.62^{a}	414.9^{ab}	772.5^{a}	1307.5^{a}	1904.1^{a}	2533.4^{a}
	10	79.62^{a}	387.6^{b}	742.6^{a}	1284.0^{a}	1818.3^{a}	2376.6^{a}
	20	92.12^{a}	435.8^{a}	799.8^{a}	1349.5^{a}	1830.0^{a}	2173.7^{a}
	30	81.75^{a}	409.6^{ab}	772.9^{a}	1359.1^{a}	1796.8^{a}	2278.2^{a}
	P >	**0.1362**	**0.1162**	**0.3640**	**0.2344**	**0.1840**	**0.0564**
	Between canola forms						
	W	88.35^{a}	420.8^{a}	798.6^{a}	1358.0^{a}	1916.8^{a}	2493.8^{a}
	G	79.81^{b}	399.5^{a}	743.8^{b}	1270.3^{b}	1710.3^{b}	2127.4^{b}
	P >	**0.0134**	**0.0586**	**0.0067**	**0.0078**	**0.0006**	**0.0007**
Cumulative feed Conversion, Kg/Kg	**Among levels of Canola**						
	0	0.738^{b}	1.298^{b}	1.402^{c}	1.571^{c}	1.795^{c}	1.877^{d}
	5	0.739^{b}	1.396^{b}	1.430^{c}	1.637^{c}	1.815^{c}	1.982^{cd}
	10	0.733^{b}	1.348^{b}	1.434^{c}	1.724^{c}	1.922^{c}	2.113^{c}
	20	0.817^{ab}	1.577^{a}	1.684^{b}	1.984^{b}	2.171^{b}	2.400^{b}
	30	0.850^{a}	1.694^{a}	1.884^{a}	2.553^{a}	2.824^{a}	2.750^{a}
	P >	**0.0234**	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0001**
	Between canola forms						
	W	0.795^{a}	1.450^{a}	1.539^{a}	1.794^{a}	2.012^{a}	2.100^{a}
	G	0.760^{a}	1.519^{a}	1.643^{b}	2.053^{b}	2.299^{b}	2.303^{b}
	P >	**0.1105**	**0.5430**	**0.1243**	**0.0041**	**0.0001**	**0.0002**

[1] Means that are not carrying the same superscripts are significantly different, P<0.05
W = Whole, G = ground

Table 15. Effect of some interactions between level, form of Canola seeds and sex of the birds on broilers dressing Parameters[1]

Source of variation	Dressing %	Fat wt, gm	Fat %, Dressed	Fat, % Live
Level X Sex				
0 F	73.75± 5.87	3.600± 3.647	0.398±0.224	0.306±0.189
0 M	79.33± 1.51	9.800± 7.791	0.676±0.349	0.536±0.278
5 F	71.18±21.74	10.345±10.78	1.863±3.603	0.611±0.575
5 M	77.89± 4.90	8.033± 7.735	0.588±0.464	0.458±0.363
10 F	78.35± 7.82	8.067± 8.884	0.585±0.469	0.454±0.372
10 M	77.78± 4.12	10.414±12.009	0.622±0.568	0.478±0.434
20 F	74.70± 3.94	5.287± 7.343	0.615±0.858	0.460±0.630
20 M	77.60± 2.54	4.475± 3.940	0.390±0.273	0.308±0.221
30 F	75.37± 7.29	4.000± 4.528	0.558±0.519	0.438±0.391
30 M	76.54± 2.66	3.112± 4.370	0.382±0.352	0.300±0.276
P >	**0.6148**	**0.7310**	**0.5492**	**0.7652**
Level X form				
0	76.08± 5.28	6.700± 6.600	0.537±0.313	0.421±0.255
5 G	72.54±19.07	7.747± 9.912	1.340±3.154	0.428±0.508
5 W	78.52± 3.56	11.750± 7.476	0.930±0.438	0.724±0.342
10 G	77.66± 8.10	1.771± 1.044	0.231±0.147	0.172±0.093
10 W	78.47±3.97	16.133±10.391	0.950±0.483	0.740±0.372
20 G	75.75± 3.59	4.908± 6.968	0.574±0.809	0.436±0.598
20 W	76.79± 3.55	4.767± 3.733	0.394±0.193	0.306±0.153
30 G	77.18± 4.86	1.628± 0.912	0.270±0.092	0.212±0.080
30 W	75.72± 4.80	4.100±4.954	0.502±0.460	0.389±0.355
P >	**0.6554**	**0.0010**	**0.3776**	**0.0084**
Form X Sex				
G F	73.19±17.22	6.400± 9.553	1.177±2.782	0.442±0.601
G M	77.20± 3.74	3.078± 3.868	0.309±0.252	0.242±0.205
W F	76.12± 5.06	7.603± 7.507	0.640±0.439	0.500±0.347
W M	78.04± 3.29	10.421±9.480	0.703±0.473	0.546±0.364
P >	**0.6418**	**0.0333**	**0.1716**	**0.1280**

1. Means within a column that are not followed with the same superscript are significantly different, P<0.05

Table 16. Effect of Canola level, form and sex of the bird on broilers dressing Parameters[1]

Source of variation	Dressing %	Fat wt, gm	Fat %, Dressed	Fat, % Live
Among canola levels				
o	76.08^{a}	6.700^{ab}	0.537^{a}	0.421^{a}
5	74.53^{a}	9.139^{a}	1.197^{a}	0.531^{a}
10	78.08^{a}	9.200^{a}	0.603^{a}	0.466^{a}
20	76.21^{a}	4.844^{ab}	0.492^{a}	0.377^{a}
30	76.11^{a}	3.373^{b}	0.434^{a}	0.337^{a}
P >	**0.8534**	**0.0330**	**0.4530**	**0.3143**
Between canola forms				
Whole	77.05^{a}	9.089^{a}	0.673^{a}	0.524^{a}
ground	75.40^{a}	4.522^{b}	0.686^{a}	0.329^{b}
P >	**0.3450**	**0.0044**	**0.9708**	**0.0194**
Between sex of the birds				
Male	77.64^{a}	6.950^{a}	0.516^{a}	0.402^{a}
Female	74.90^{a}	7.080^{a}	0.874^{a}	0.475^{a}
P >	**0.0717**	**0.8549**	**0.2126**	**0.4609**

1. Means within a column that are not followed with the same superscript are significantly different, $P<0.05$

5.3.2. References

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جامعة الملك فيصل

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قسم المحاصيل والمراعي

في
كلية العلوم الزراعية والأغذية

التقرير النهائي

عن

إستخدام حبوب الكانولا (Brassica Napus, L.) في علائق الدواجن

د/ هذيل نجيب عبدالرحمن
د/ سليمان بن علي الخطيب

ربيع الأول ١٤٢٤هـ