An-Najah National University
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Utilization of Citrus Pulp in Broiler Rations

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DEDICATION

This project is dedicated to the martyrs of my country

To the soul of my father

To my mother, brothers and sisters

To my wife Lama and daughter Yara

with my love and adoration

The completion of this work was not possible without their support, courage and help

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List of Contents

List of Tables

List of figures

List of Abbreviations

GATT	General Agreement for Tariff and Trade
COD	Chemical Oxygen Demand
BOD	Biological Oxygen Demand
TDN	Total Digestible Nutrients
FAO	Food and Agriculture Organization
DM	Dry Matter
CP	Crude Protein
CF	Crude Fiber
EE	Ether Extract
NFE	Nitrogen Free Extract
DCP	Dried Citrus Pulp
CCP	Citrus Pulp Pellets

Abstract

The research aimed to study the possibility of using citrus pulp as broiler rations this could be done by detecting the effect of citrus pulp on broiler performance, weight gain, feed intake and palatability, conversion ratio, gastrointestinal tract, and visceral organs and carcass cuts. A total of 150 day-old chicks were reared for two weeks, and then 128 of the medium birds were divided into four equal weight groups with four replicates each. And were placed randomly on 16 suitable area bins and managed as commercial flocks. Dried citrus pulp (obtained by squeezing, grinding, drying and regrinding of the orange fruits) was used starting from the third week at 5, 7.5, and 10% of the feed instead of corn which was used at 15% of the control feed. Body weight of individuals and feed intake of replicates was recorded weekly till termination at end of week five. Four birds from each group was slaughtered and eviscerated, the weight of gastrointestinal tract and segments, visceral organs and carcass parts was recorded. Results showed similar chemical analysis of citrus pulp to that reported in literature, body weight gain and conversion ratio was not affected at levels 5 and 7.5%, but at 10% it was the lowest ($p < 0.05$). Feed intake, visceral organs, gastrointestinal tract and parts and carcass parts was not affected ($p < 0.05$). Citrus pulp was noticed to be palatable in all rations, especially at 5%; however it needs an adaptation period for levels more than 5%.

List of appendices

Chapter One
Introduction

1.1. Introduction

Feed costs contribute about 75 % of total costs of production in poultry farms, and two-thirds of costs of milk and beef production (An-Kuo, 1996), so feed costs play a major role in the profitability of a farmer, and represents a major obstacle facing the development of poultry in many parts of the world (Salah, 1999). Most of the feed stuffs available in the local market are imported, which increase the cost of meat, milk and egg production, and lower the profitability of the livestock operations. This will be a future problem after the international competition increases due to the implementation of the GATT agreement. So looking for a new local and cheap source of feed stuffs became of major importance in reducing the costs of livestock production and increasing the profitability of farming.

Palestine, as well as, the Middle East Countries is a semi coastal area, most of which are mountains and deserts, and lacks the irrigation water, so the production of crops is not enough to meet the demands of the high density populations of these countries, taking in consideration the high competition between the animals and human for feed. Fortunately, there are many agriculture by-products of good nutritive value which can be utilized as animal feeds (Abo Omar, 1995, 2000; Abd El-Ghani, 2000; Harb, *et al.,* 1986). However, most of the farmers are not aware of the nutritive value of these by–products. The potential use of a certain by-product as animal feed depends on several factors. Some of these factors are its amount and season of availability, nutritive value, the degree of processing, and competition with other uses.

Large amounts of by-products are available in Palestine among which poultry litter, tomato pomace, olive cake and citrus pulp (Abo Omar, 1995; 2000). The estimated amount of citrus fruits produced in Palestine in the year 1998/1999 is 149000 tons (Ministry of agriculture, 1999). While that estimated as a collectable citrus pulp is about 10 thousands tons (Barghouthi, *et al.,* 2001). Most of it is disposed by dumping, land filling and flushing into municipal sewage, causing many environment pollution problems, because of the high moisture and organic matter contents of the citrus pulp. These problems vary from nuisance of the fly and rodents, which accumulate on these wastes, to the chemical and biological oxygen demands (COD, BOD) (Harris, *et al.,* 1992).

The dried citrus pulp that can be easily handled and stored, as well as, the wet citrus pulp, is high in energy and calcium, but low in protein and phosphorus (Brown, 1990). Pulp containing the most seeds is greatest in protein and total digestible nutrients (TDN), approximately 80% (Brown, 1990). The low content of the phosphorus can be considered as an advantage for a feed stuff because the phosphorus content of the poultry feces represents an environmental problem for soil in some countries.

The citrus pulp pellets can be used as a poultry litter to be enriched with nitrogen then used as a source of nitrogen for cattle feeding (Sorbara, *et al.,* 2001; Nouel, *et al.,* 1999).

The objectives of the experiment were:

1- To check the chemical analysis of citrus pulp and the possibility of using such waste as part of broiler rations.

2- To investigate the performance of broilers fed different levels of citrus pulp.
3- To investigate its effect on visceral organs and carcass cuts.
4- To investigate its palatability by broilers.

1.2. Literature review

Most of the processing by-products have a high moisture and nutrient content and are easily spoiled and fermented. This means that unless they are used while still fresh they should be dried or ensiled before being used by farmers. Otherwise the farmer will face difficulties in storing, transporting and handling. This may constraint the regular use of these materials as animal feeds (Jong-Kyu, 1996). The size of the livestock farm, feeding and storage facilities, source of feed and economic and labor conditions, tend to influence the usage of such by products (Harris, *et al.,* 1992).

Although considerable data are available in literatures about these by-products as feed resources only little is known about citrus as poultry feed.

1.2.1 Citrus fruits extraction and by-products

Animals used to eat the fresh citrus fruits while grazing or when provided by farmers. Orange, grapefruits and lemon sometimes go to waste if not marketed. Cattle can consume large amounts of the fruits, up to 40 kg per day with no harmful effect (FAO, 2001). After the extraction of the juice from the orange or grapefruits 45 – 60 % of their weight remains in the form of peel, rag, and seeds (FAO, 2001; El Boushy, *et al.,* 1992). Among the by-products of

citrus processing there are a good valuable commercial by-products such as essential oils and D-Limonene and others of less commercial value by-products such as citrus pulp, citrus molasses and limited amount of citrus seed meal. Citrus pulp is considered the most important as large amount of it is produced annually (Fentress, *et al.,* 1983). El Boushy, *et al.,* (1994) reported that according to FAO in 1991 the estimated world production of fresh orange is 52 million tones.

The essential oils are volatile removed from the citrus peel, when the oil sacs break during the juice extraction these oils flashes and re-condensed with some water vapor and then separated in its liquid state. The final main product is D–Limonene which is used in flavoring, pigments, paints, pharmaceuticals, cosmetics and many other products (El Boushy, *et al.,* 1994). Figure (1) shows the different products and by- products of the citrus processing.

The feeding value of citrus by-products, as well as, percentages in the fruits varies depending on the variety, maturation, season, and processing method.

1.2.2 By–products of citrus processing in animal feed

1.2.2.1 Citrus seed meal

It is a by-product of oil extraction from the citrus seeds. It compares favorably with many sources of vegetable protein specially cotton seed meal (FAO, 2001). It contains limonin (0.01 % of dried citrus pulp), which is toxic to pigs and poultry, at 5 % inclusion in poultry feed the growth reduced (FAO,

2001), at 20 % causes mortality in broilers (FAO, 2001; El Boushy, *et al.,* 1994), at 10 % of pig feed, growth depression was noticed (Harb, 1971). It has no effect on ruminants (FAO, 2001). In an experiment conducted to detect any effect of limonin on cattle, the citrus seed meal was compared to cotton seed meal in the ration of fattening steers, no significant difference was apparent with respect to weight gain, carcass grade, shrinkage and yield (Harb, 1971). The chemical composition of citrus seed meal is shown in table 1.

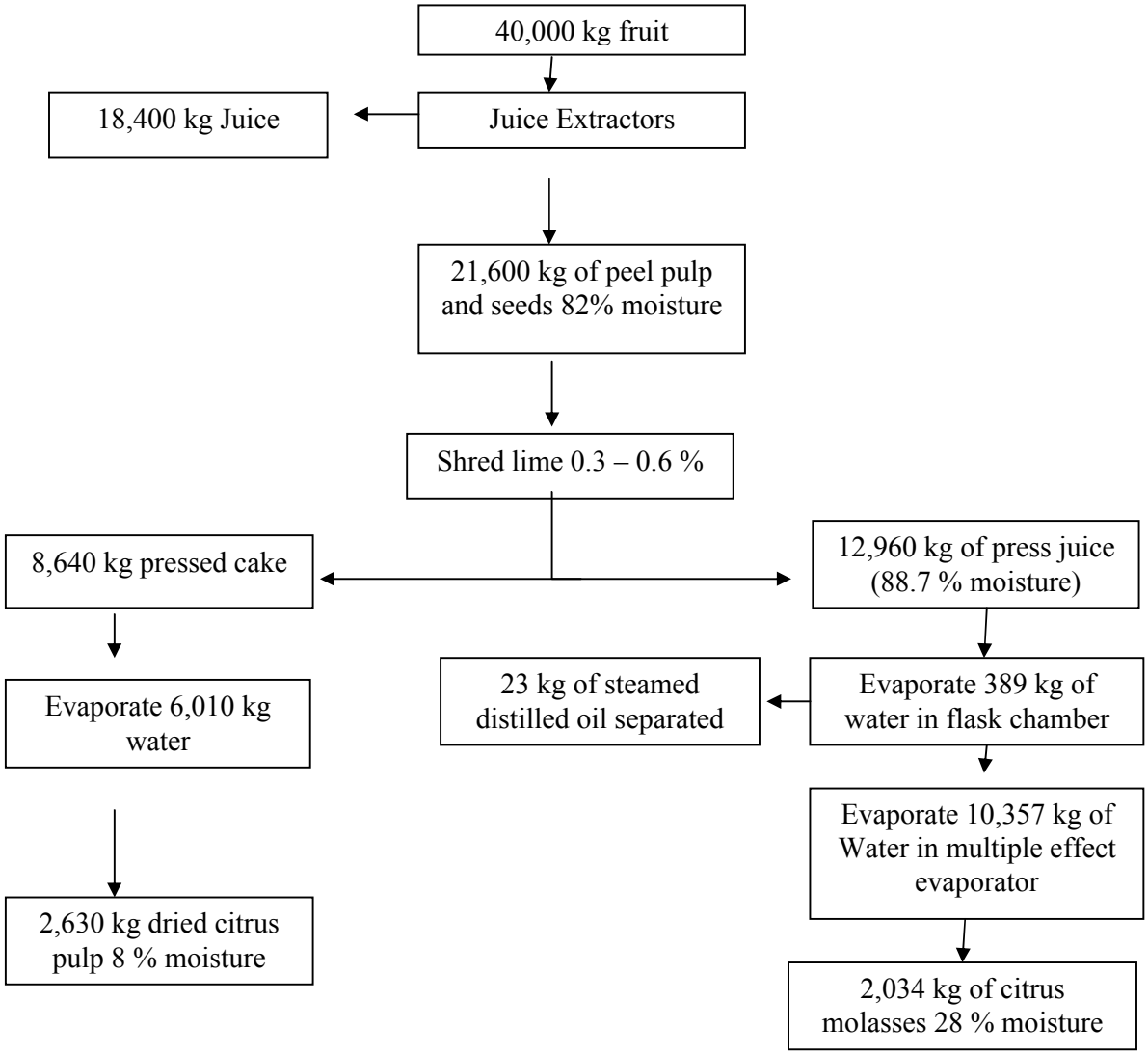

Figure 1. Flow and material balance sheet for the processing of citrus residue into dried citrus pulp and molasses (Harb, 1971)

1.2.2.2 Citrus molasses

It is the liquid obtained by pressing the citrus waste, contains 10-15% soluble solids of which 50-70 % are sugars (FAO, 2001; El Boushy, *et al.,* 1994). This material, which represents about 50 % of the citrus waste, can be concentrated into citrus molasses (Fig 1) which is a thick viscous dark brown to black liquid, with a very bitter taste for human (due to presence of naringin), but not for animals (El Boushy, *et al.,* 1994), except for pigs which are less readily accepted it (FAO, 2001). Fentress, *et al.,* (1983) reported that replacing one half of the ground snapped corn with citrus molasses in steer fattening results in greatest gain. It can be used in the same way as sugar cane molasses, and can replace 10 – 40 % of maize in the pig rations depending on the age of the pigs (FAO, 2001). Table 1 shows the chemical analysis of the citrus molasses.

1.2.2.3 Citrus pulp

It refers to the waste of juice extraction which contains peel, rag (pulp), and seeds and represents 45-60 % of the fresh weight (El Boushy, *et al.,* 1994; FAO, 2001; Jong-Kyu, *et al.,* 1996). Its utilization for livestock was proposed in 1916 by Dec Dermott (Harb, 1971). It contains 15-20 % dry matter and consists of 60-65 % peel , 30-35 pulp and 0-10 % seeds (Jong-Kyu, *et al.,* 1996), due to its low protein, high carbohydrate and moderate fiber content (table 1), citrus pulp is considered as an energy source. Attention should be made to the calcium–phosphorus ratio when feeding citrus pulp because it is low in phosphorus and high in calcium (Brown, 1990). On a laboratory analysis basis it compares

favorably with ground snapped corn with respect to TDN (Fentress, *et al.,* 1983). Table 2 shows the amino acid content of citrus pulp.

Table 1. Chemical analysis of different citrus products as % of dry matter.

Citrus product	DM	CP	CF	Ash	EE	NFE	Ca	P
Fresh whole grapefruit	12.7	7.0	8.7	3.9	2.4	78.0	0.79	0.16
Fresh whole orange	12.8	7.8	9.4	4.7	1.6	76.5	0.47	0.23
Grapefruit pulp	20.3	6.4	10.5	4.1	0.4	78.6	0.61	
Grapefruit peels	17.9	6.7	10.6	3.9	1.7	77.1		
Orange peels	16.1	6.8	6.2	3.7	1.9	81.4	1.30	0.12
Silage of grapefruit peel	19.2	7.3	13.0	4.2	2.0	73.5		
Silage of orange peels	19.6	7.7	14.3	5.1	2.6	70.3	1.38	0.10
Dried citrus pulp	91.8	6.9	13.1	7.1	2.8	70.1		
Citrus fruit meal		8.1	11.4	5.5	3.9	71.1	4.27	0.09
Citrus molasses	71.0	5.8	0.0	6.6	0.3	87.3	1.13	0.08
Citrus seed meal	85.0	40.0	8.8	7.0	6.7	37.5	1.65	0.10

(FAO, 2001)

Citrus pulp can be fed either wet or dry; both should be considered as equal in nutritive value on dry matter basis. The second is easily handled and transported so become the most common form available; while wet citrus pulp can be fed either as it is or can be turned into silage.

1.2.2.3.1 Wet citrus pulp

It contains about 80% water so fed to livestock only in the farms that is close to the processing plants. It is difficult to handle because ferments and spoils quickly. Usually offered free choice and if consumed on high levels cattle

may experience ruminal problems that can adversely affect performance and may cause death, so should not exceed 10 % of the total diet on dry matter basis (John, *et al.,* 2001). Cattle consume the seeds and rage first when wet pulp is offered and after some of the volatile oils evaporated cows return to consume the peels (Harb, 1971). It should be offered to dairy cows shortly after milking in order to avoid flavoring the milk (FAO, 2001; Harb, 1971).

Due to the fact that wet citrus pulp is available for 3 months a year only, and to its high moisture content which put constraints in using it all over the year. Making silage from it becomes an identical solution. Because it contains high level of NFE (Nitrogen Free Extract) which is good substrate for fermentation, it can be easily fermented and turned into silage within 50 days, (FAO, 2001; Jong-Kyu, *et al.,* 1996).

Citrus pulp silage can be used till 20 % replacement of feed concentrate (Jong-Kyu, *et al.,* 1996). Fresh citrus pulp can be used as ensiling additive (up to 20 %) to tropical grasses that do not ensiled by themselves. This 20% citrus pulp is expected to lower the pH and increase lactic and acetic acid fermentation. Table 1 shows the chemical analysis of wet citrus pulp and silage.

1.2.2.3.2 Dried citrus pulp

Drying of citrus pulp made it possible to use all over the year, and reduce the risk of spoiling, as contains low water content. Direct drying is not easy because of the slimy consistency of the pulp due to the hydrophilic nature of the pectin in it. This nature can be destroyed by adding 0.3-0.5 % lime ($Ca(OH)_2$),

after crushing the peel into smaller pieces the limestone alters the pectin into pectate, then the citrus pulp can be pressed and dried to about 10 % moisture, the resulting liquid is the molasses. The dried citrus pulp can be screened to erase the fine particles and sold as citrus meal, or the whole product is kept as dried (or dehydrated) citrus pulp (DCP), or citrus pulp pellets (CPP) when pressed and converted to pellet, which increase the bulk density. CPP can be used as poultry litter because it is good water absorbent, and then can be used as diet supplement based on poultry litter for cattle (Nouel, *et al.,* 1999).

Table 2. Citrus pulp content of amino acid as % of crude protein.

A	Arg.	His.	Ils.	Leu	Lys.	Met	Phe.	Thr.	Try.	Tyr	Val.
%*	4.8	1.6	3.1	5.3	3.4	1.4	3.1	3.1	1.0	-	4.3
%**	4.6	1.7	4.9	-	3.1	0.83	2.9	3.0	-	2.9	3.7

*FAO, 2001; ** Harb, 1971

1.2.3 Dried citrus pulp as ruminant feed

Dried citrus pulp is considered second to corn as a source of concentrated feed nutrient for dairy and beef cattle and sheep. It is low in carotene (ingredients 101, 2002). Jong-Kyu, *et al.,* (1996) reported that replacing 30 % of concentrates of dairy cows with citrus pulp did not affect the milk yield or fat content, also no significant difference was found in animal gain or efficiency of utilization between citrus pulp and ground snapped corn on streers (Fentress, 1983). In an experiment to compare dried grapefruits pulp and dried beet pulp

in according to digestibility and milk production in dairy cows, no difference was noticed and no flavor has passed to the milk (Harb, 1971). In another experiment, 50 % DCP and 50 % corn and cob meal where fed to dairy cows, in most of the treatments cows showed little increase (but not significant) in the milk yield in the corn and cob fed groups (Harb, 1971). Bueno, *et al.,* (2002) reported that replacing around 40 % of corn by DCP can attain the best performance for growing kids.

Backer, *et al.,* (1951) found that when balance diet with DCP was fed to Jersey calves, it exerted a mild laxitative effect on the digestive tract, and gave the hair coat a glossy appearance (Harb, 1971). Fentress, *et al.,* (1983) reported that cattle fed citrus pulp had loose feces but there was no scouring.

1.2.4 Dried citrus pulp as monogastrics and poultry feed

Due to the toxic effect of limonene which is present in citrus seeds on pigs and poultry, and the relatively high fiber content, the use of DCP for pigs and poultry is restricted to small percentages.

An experiment was conducted by Yand and Chang (1985) to investigate the effect of DCP on pigs, the DCP was provided at levels of 0, 5, 10 and 15 % for 76 days for the growing pigs, they found that the weight gain and feed intake increases up to 10 % of DCP in the diet, the carcass quality was apparently improved by increasing meat content and carcass length and reducing back fat (El Boushy, *et al.*, 1994). Jong-Kyu, (1996) experimented three rations containing 0, 10, and 25 % citrus seed meal for pigs and found that citrus seed meal was harmful to pigs even at 10 % level in rations.

Yand and Chang (1985) examined the effect of citrus peel and pulp on broilers, the weight gain and feed intake decreases as the citrus level increases. But the heated dried peel could replace 5 % of the diet of the broilers without any negative effect (El Boushy *et al.,* 1994). Another experiment was conducted on layers, no effect have been noticed at levels of 5 and 10 % of dried peel, but at 15 % there was decline in egg production and feed intake (El Boushy, *et al.,* 1994). The yolk color was adversely affected even at level of 2.5 % (FAO, 2001).

Ewing, (1963) examined the effect of citrus pulp on broilers and noticed decreased growth rate during the first 4 weeks, 20 % citrus pulp in diet resulted in a high mortality (El Boushy, *et al.,* 1994). At 10 % inclusion higher feed intake per unit of gain was noticed, and no extra mortalities happened (El Boushy, *et al.,* 1994).

Another experiment conducted by Buriel, Criollo, and Rivera (1976) by using high levels of 0, 20, 30 and 40 % citrus pulp in broiler starter and finisher diets, the results showed that citrus pulp cannot be used at levels of 20 % or more (table 3), the experiment did not show the effect of using DCP at levels lower than 20 % (El Boushy, *et al.,* 1994). These low levels can be considered of great importance for poultry industry.

Table 3. Average body weight, feed consumption and conversion of broilers fed various levels of dried citrus pulp in comparison with a control diet.

Treatment	Average weight (g/chick)		Feed consumption (g/chick)		Feed conversion (g/chick)	
	0-4 wks	0-8 wks	0-4 wks	0-8 wks	0-4 wks	0-8 wks
Control	661[a]	1669[a]	1154[a]	3036[a]	1.6[a]	1.8[a]
20%	571[b]	1374[b]	1054[a]	3156[b]	1.8[a]	2.3[b]
30%	459[c]	1293[b]	1365[b]	3374[c]	3.0[b]	2.6[b]
40%	408[d]	1099[c]	1541[c]	3396[c]	3.8[b]	3.1[b]

[a.b.c.d] Means within a column with the same superscript are not significantly different at $p < 0.01$ (Adopted from El Boushy, *et al.,* 1994)

El Boushy, *et al.,* (1994) reported that DCP products has 83 % and 81 % digestibility in poultry for grapefruits and orange respectively, the digestible coefficient of NFE is 88 – 92 %, the digestibility of protein is low, only about 24.8 and 36.6 % respectively for grapefruits and orange.

1.2.5 Palatability of citrus pulp

Citrus pulp is considered a palatable feed especially for cattle, (Harb, 1971). Mature cattle accustomed to this feed will consume 6-10 kg a day, with preferably the grapefruit more than orange on the opposite of pigs (FAO, 2001). Nouel and Combellas (1999) reported that the addition of citrus pulp as a supplement diet based on poultry litter resulted in more than two - fold consumption increment.

Battacharya and Harb (1973) reported that no significant difference was found between the palatability of citrus pulp and corn on wether lambs.

Chapter Two
Materials and Methods

2.1 Preparation of the dried citrus pulp

The row materials (downgraded fruits) were obtained from local market. The fruits were manually squeezed and the by-product (pulp after extraction of juice) was separated. Pulp was grinded using the usual manual meat grinding machine. Then was dried in sun for five days, mixing every few hours was performed to assure an efficient drying. The dry material was finely grinded and kept in air tight bags for later use. Sample was taken for later proximate analysis.

2.2 Chemical analysis of dried citrus pulp

Samples of the dried citrus pulp were taken and analyzed for moisture, crude protein, crude fiber, ether extract, ash, calcium and phosphorus, the NFE was calculated by difference.

[NFE % = 100 % - (C. protein % + C. fat % + C. fiber % + ash %)].

2.3 Preparation of the rations

The amount of rations needed for the experiment and the ingredients of the rations were calculated in advance according to the NRC (1984) requirements. Two types of rations were used, the starter and the finisher, the starter was fed for the first 2 weeks and was prepared before the start of the experiment (Table 4). After ten days of starting the experiment the 4 finisher experimental rations, which will be fed for weeks 3-5 was prepared, these rations which is shown in table (5) were:

Diet 1: Control ration contains 0% citrus pulp.

Diet 2: Experimental ration contains 5 % citrus pulp.

Diet 3: Experimental ration contains 7.5 % citrus pulp.

Diet 4: Experimental ration contains 10 % citrus pulp.

Table 4. Starters ration composition and analysis.

Starter composition	**%**
Corn	21
Wheat	32
Soy bean meal	39
Dicalcium phosphate	1.6
Sand	1.4
Oil	4
Premix	1
Chemical analysis	
Component	**%**
Dry matter	89
Crude protein	22.5
Crude fiber	4
Crude fat	5
Ash	6.5
Calcium	1.2
Phosphorus	0.8

Table 5. The composition and chemical analysis of the 4 finisher experimental rations used in the experiment.

Diet	**1**	**2**	**3**	**4**
		Diet composition %		
Corn	15.0	10.0	7.5	5.0
Wheat	44.6	44.6	44.6	44.6
Soy bean meal	31.4	31.4	31.4	31.4
Di-calcium phosphate	1.6	1.6	1.6	1.6
Sand	1.5	1.5	1.5	1.5
Oil	5.0	5.0	5.0	5.0
Premix	0.9	0.9	0.9	0.9
Citrus pulp	0	5.0	7.5	10.0
		Chemical analysis %		
Dry matter	88.0	88.0	88.0	88.0
Crude protein	19.4	19.3	19.25	19.20
Crude fiber	4.3	4.8	5.1	5.3
Crude fat	4.5	4.4	4.4	4.3
Ash	5.7	5.9	6.0	6.1
Calcium	0.8	0.82	0.83	0.84
Phosphorus	0.6	0.6	0.6	0.6

2.4 Performance experiment

A total of 150 one day-old broiler chicks were bought from a local hatchery (Palestine Poultry Company Hatchery). Chicks, originated from a 36 weeks age Hybro G Broiler Breeders flock, was transferred to the experimental site and weighted. The experimental rations were used starting from the beginning of the third week, and so all the 150 birds were reared together on a wood shaving covered floor with suitable area under the same feeding, drinking, and brooding conditions.

Birds were managed, treated and vaccinated as any commercial broiler flock. Feed and water were provided *ad lib*. The weekly average body weight and feed intake of the birds were recorded. Starting from the third week, 18 birds of the extreme low and high weights were excluded, and the rest 128 birds of the medium and uniform weights were divided in a completely randomized design (CRD) into 4 equal weight groups of 32 birds each to be treated as a treatment group, each group was divided into 4 equal weight replicates with 8 birds each. The 16 replicates were allocated randomly into 16 equal and suitable area size, with wood shaving covered floor with a feeder and drinker to each replicate. Birds were kept in pens till the termination of the experiment at 35 days old.

During the experimental period (15-35 days) the individual body weight and feed intake of each replicate was recorded at weekly bases. The average daily weight gain, average daily feed intake, and average conversion ratio where then calculated.

2.5 Carcass cuts and visceral organs

At the end of the experiment one bird from each replicate was taken (4 from each feeding group) and was slaughtered as routinely practiced in a commercial slaughter house. Birds were eviscerated and the weights of edible and inedible parts and lengths of some selected parts were measured, carcass and carcass segments were also weighted and recorded. ANOVA by using the Genstat software was employed to detect any effect of the citrus pulp used in the rations on the broilers results.

Chapter Three
Results and discussion

3.1 composition of citrus pulp

The composition of citrus pulp as analyzed is shown in table 6.

Table 6. Composition of used dried citrus pulp.

Composition	DM basis %	As feed basis %
Moisture	-	10.8
Dry Matter	100	89.2
Crude Protein	7.42	6.62
Crude Fiber	12.9	11.5
Rude Fat	3	2.7
ASH	5.7	5.08
NFE	71	63.3
NDF	16.03	14.3
ADF	10.76	9.6
Calcium	1.12	1
Phosphorus	0.45	0.4

The dry matter content of the citrus pulp is consistent with that reported by FAO (2001) and Harris, *et al.,* (1992). Also the protein content equals that reported by FAO (2001) and higher than what reported by Harris, et al. (1992) but lower than resulted by Harb (1971). The variation in protein content may be attributed to the different seed content (which is high in protein) of the citrus used. The percent of seeds in the citrus fruits varies from 0 – 10% (Jong-Kyu, *et al.,* 1996).

The moderate content of fiber, despite the bulky nature of citrus pulp, allows considering it as a concentrate and not roughage (Harb, 1971). The fiber content of the citrus pulp as analyzed is in agreement with that reported by other researchers (Ingredients 101.2002; FAO, 2001; Harb, 1971). Similar trend was observed for the NFE fraction. The high percent of the NFE indicated that citrus pulp contained high percent of digestible carbohydrates.

The calcium and phosphorus contents were similar to the averages reported by other researchers (Harb, 1971).

3.2 Broiler performance

Table 7 shows the bird's weekly average body weight of the different treatments from the beginning of the experiment (beginning of week 3) till the end of the experiment (end of week 5). The initial and the weekly weights of the first 2 weeks were included.

Table 7. Average weekly body weights of the 4 treatments in the different ages of the birds (g/bird).

Age / Weeks	1	2	3	4
0	40.5	40.5	40.5	40.5
1	140.4	140.4	140.4	140.4
2	353.0	353.0	353.0	353.0
3	706.3	701.3	682.0	662.7
4	1145.5	1116.3	1134.5	1079.7
5	1619.6 a	1603.6 a	1601.9 a	1510.2b

Rows of different letters means significantly different ($P < 0.05$)

The table shows that there was no significant difference in the average body weights in the first 2 weeks of the experiment but there was a significant difference ($p < 0.05$) at termination of the experiment (at end of week 5). This result is in agreement with the result reported by Abo Omar, *et al.,* (2000) when a high fiber diets (olive pulp) were fed to broilers, and with El Boushy, *et al.,* (1994) in feeding the citrus pulp to the layers.

Table 8. Average daily gain of the birds in the different weeks of the experiment for the 4 treatments fed different rations containing 0, 5, 7.5, and 10 % citrus pulp (g/bird/day)

Age / Weeks	1	2	3	4
3	50.5 a	49.8 ab	47 bc	44.2 c
4	62.8	59.3	64.6	59.6
5	67.7	69.6	66.8	61.5
3-5 (Experimental period)	60.3 a	59.6 a	59.5 a	55.1 b
0-5 (Total rearing period)	45.1 a	44.7 a	44.6 a	42 b

Rows of different letters means significantly different ($P<0.05$)

Table 8 shows that the weekly average daily gain is only different ($P<0.05$) in the first week of the experiment, this might be due to the start using a new kind of feed with higher fiber content or a different taste or both. In this week as noticed from table 8 the average daily gain decreased as the percent of citrus pulp increased, this effect of the daily gain in week 3 affects the average daily gain of the whole experimental, and of course rearing period, so this effect is the responsible for the difference in body weight appears at termination of the experiment (table 7).

3.3 Feed intake

Table (9) shows that the average daily feed intake for the different weeks of the experiment is only different ($p<0.05$) in the first week. The average daily intake was lower for treatment received 7.5 and 10 % citrus pulp ($P< 0.05$). This means that after the first week of the experiment and after the birds became adapted to the new taste. Birds consumed the same levels of the feed. Feed intake of the birds table 9 also ensures this conclusion.

Table 9. Average daily feed intake by birds in the different weeks of the experiment for the 4 treatments fed different rations containing 0, 5, 7.5, and 10 % citrus pulp (g/bird/day).

Age / Weeks	1	2	3	4
3	79.9 ab	82.4 a	79.0 b	76.8 b
4	115.2	120.0	123.1	126.0
5	157.3	157.2	156.1	153.4
3-5	117.5	119.9	119.4	118.7
1-5	84.1	85.5	85.2	84.8

Rows of a different letters means significantly different ($P<0.05$)

However for the whole experiment and rearing period no significant difference was noticed. Even the feed consumption of the different experimental rations (table 10) shows that the feed consumption of the treatments received the feed containing the citrus pulp is higher than that received the control ration. This tendency of feed consumption might be due to the higher palatability of the citrus pulp in comparison to other feed ingredients, or due to the laxitative effect of the citrus pulp in the ration, as reported by Backes, *et al.,* 1951 and Harb, 1971.

Table 10. Average feed consumption in the different weeks of the experiment for the 4 treatments fed different rations containing 0, 5, 7.5, and 10 % citrus pulp (g/bird/week)

Age / Weeks	1	2	3	4
1	175.2	175.2	175.2	175.2
2	476.0	476.0	476.0	476.0
3	1035.2 a, b	1052.9 a	1029.3 b	1013.4 b
4	1841.8	1893.1	1890.7	1895.4
5	2943.1	2993.8	2983.4	2969.3

Row of different letters means significantly different ($p <0.05$)

3.4 Feed conversion ration:

Table 11 shows the feed conversion ration of the different treatments of the experiment.

Table 11. Feed conversion ratio of the 4 treatments fed 0, 5, 7.5, and 10 % citrus pulp.

Age/weeks	**1**	**2**	**3**	**4**
Conversion. Ratio	1.818 a	1.868 a	1.864 a	1.967 b

Row of different letters means significantly different ($p<0.05$)

Table 11 shows that significant difference appears to be only in the group received 10% citrus pulp. This means this group has the highest feed intake per unit of body weight gain. This result consistent with that reported by Ewing, 1963 (El Boushy, *et al.,* 1994).

3.5 Palatability

Citrus pulp seems palatable for the broilers, because, as noticed from table 10, citrus pulp containing feed was consumed higher than the control. Highest consumption at week 3 was reported in the treatment received 5% citrus pulp. This also may assure that the palatability at 5% citrus pulp is high since the start of the experiment, and that at this level of citrus pulp the taste of the feed was positively affected with no need for any adaptation period as the higher percentages, especially for such a bulky feed (Kyriazakis, *et al.,* 1995). At the second week of the experiment the average daily feed intake (table 9) increased as citrus pulp increased, despite the bulky natures of citrus pulp, which assure the high palatability of citrus pulp.

This tendency is also noticed in the last week of the experiment on which the relative feed intake to the body weight was increased as the citrus pulp in the feed increased. Opposite of what stated by Kyriazkis *et al.,* (1995) and despite of

considering the citrus pulp as a good absorbent and a high water- holding capacity it does not limit the feed consumption.

May be because this nature of the feed increased the passage rate of the feed due to the higher content of the water, this was noticed by the noticeable wet feces of the groups received the 7.5 and especially 10% citrus pulp.

3.6 Visceral organ mass

Although it was reported by Abu Omar, *et al.,* (1995) that the high levels of fiber influence the gastrointestinal tract this influence was not clear in this experiment may be because increment of the fiber content in the rations did not exceed 1.2% at most.

3.6.1 The edible parts

These parts are gizzard, liver, and heart.

Table 12. Percentages of the edible parts to the live weight of the 4 treatments fed 0, 5, 7.5, and 10 % citrus pulp (% of live weight).

Organs	**1**	**2**	**3**	**4**
Liver	2.733	8.764	3.064	2.837
Gizzard	2.495	2.624	2.281	2.298
Heart	0.662	0.595	0.644	0.627

As shown from the table 12 the type of diet didn't affect weight percentages of these organs ($p< 0.05$).

3.6.2 The non-edible parts:

These parts are: esophagus, crop, lungs, proventriculus and trachea as shown in table 13.

Table 13. Percentages of non-edible parts to the live weight of the 4 treatments fed 0, 5, 7.5, and 10 % citrus pulp (% of live weight).

Organs	**1**	**2**	**3**	**4**
Esophagus	0.272	0.280	0.261	0.209
Crop	0.306 b	0.420 a	0.296 b	0.348 ab
Lungs	0.594 a	0.402 b	0.540 a	0.505 ab
Proventriculus	0.730	0.857	0.696	0.714
Trachea	0.255	0.157	0.209	0.174

Rows of different letters mean significantly different ($p < 0.05$)

There were no significant difference ($p < 0.05$) in the esophagus, proventriculus and trachea. But for the crop and lungs there was difference as shown in the table (13) especially for trt2 and less difference for treatment 4, which indicates that this difference is not related to the diets.

3.6.3 Gastrointestinal tract

As shown in table 15 there is no significant difference ($p < 0.05$) that might be caused by the diet and the only different organ is the cecum of group 4. Although as noticed from the table the gastrointestinal tract (not significant at ($p<0.05$)) of the groups received citrus pulp is higher than control. This assure the earlier assumption that the birds received citrus pulp retentively consumed more feed than control.

Table 14. Percentages of some components of the gastrointestinal and digestive tract and contents to the live weight of the birds in the 4 treatment containing 0, 5, 7.5, and 10 % citrus pulp (% of live weight).

Organs	**1**	**2**	**3**	**4**
Small intestine	4.991	5.003	5.31	5.048
Large intestine	0.255	0.262	0.296	0.296
Cecum	0.696 a	0.682 a	0.662 a	0.540 b
Total dig. tract and content	18.384	19.454	19.499	19.147

Rows of different letter means significantly different ($p < 0.05$)

3.6.4 Percentage of some carcass cuts and meat

These parts as shown in table (15) are thighs, thighs meat, breast, breast meat, neck, wing, back, feet, and head.

Table 15. Percentages of some carcass cuts and meat and other parts to live weight of the 4 treatments fed 0, 5, 7.5, and 10 % citrus pulp (% of live weight).

parts	**1**	**2**	**3**	**4**
Thighs	17.81	17.56	18.68	18.43
Thighs meat	14.36	13.72	14.56	14.44
Breast	19.67	19.61	18.51	20.56
Breast meat	17.65	17.46	16.15	18.26
Neck	3.802	4.006	4.213	4.125
Wings	6.841	7.173	7.556	7.328
Back	11.526	10.952	10.463	10.513
Feet	4.023	3.691	4.248	4.056
Head	2.054	2.082	2.228	2.362

No significant difference ($p<0.05$) was noticed between treatments which indicates that citrus pulp has no effect on these parts.

3.7: Gastrointestinal length

The different citrus pulp content of the diets has no effect ($p< 0.05$) on these lengths as shown from table (16)

Table 16. Lengths (cm) of different parts of the gastrointestinal tract of the 4 treatments.

Parts	**1**	**2**	**3**	**4**
Small intestine	228 b	257 a	241.5 b	233.25 b
Large intestine	9.95 b	12.13 a	10.5 b	10.75 b
Cecum	24.13	24.88	25.0	25.25
Esophagus	10.45	10.38	11	9.5

Rows of different letters means significantly different ($p< 0.05$)

The measurements above shows that treatment 2 (fed 5 % citrus pulp), has the longest large and small intestine, the biggest crop and smallest lungs ($p<0.05$), also the biggest gizzard (not significant). All these differences might be caused by the highest consumption of the feed at the first week of the experiment (week 3 of the bird's age); this may enhance the enlargement of the gastrointestinal tract on an early age while still under developing stage.

3.8 The dressing percent

As shown in table 17 the dressing percent of the birds was not affected significantly ($p< 0.05$) by the types of rations used.

Table 17. The live and carcass weights and the dressing percent of the different treatments.

Parameter	1	2	3	4
Live weight (g)	1473.0	1429	1436	1436
Carcass weight (g)	878	847	854	875
Dressing percent (%)	59.633	59.272	59.488	60.957

3.4 Conclusions and Recommendations

3.4.1 Conclusions

1. The chemical analysis of citrus (orange) pulp is in agreement with that reported by other researches.
2. Up to 7.5% citrus pulp in broiler rations has no effect on body weight but at 10% causes low body weight.
3. Feed consumption of citrus pulp feed is higher (not significant) than the consumption of the control.
4. No effect of citrus pulp was reported on the gastrointestinal tract and segments.

5. No effect was reported on visceral parts and carcass or dressing percent.
6. An adaptation period is needed when start feeding citrus pulp, especially at levels higher than 5%.
7. At 5%, citrus pulp palatability of feed increased without any need for adaptation period, also the digestive tract segments increased.
8. Despite the fact that the citrus pulp is a bulky and water absorbent, its consumption was not affected significantly but the feces are more wet which indicates higher water consumption.
9. Some savings can be made by using citrus pulp in broiler diets.

3.4.2 Recommendations

1. Additional research is recommended to assure the positive effect of citrus pulp on broilers.
2. The adaptation of broilers to citrus pulp needs more investigation.
3. Water consumption of broiler receiving citrus pulp needs more investigation.
4. More experiments are recommended to detect the exact effects of citrus pulps on weight gain and methods of improving the gain.

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Appendices

Table 1. Body weights of individual birds of the 4 treatments at end of week 3.

Weight of individuals for all treatments at end of wk 2 = 353 gm

Replicate	1	2	3	4
R 1	680	845	780	490
	765	640	760	715
	715	600	725	595
	790	625	580	810
	815	730	645	725
	595	645	570	725
	760	795	830	560
	660	715	585	625
SUM R 1	5780	5595	5475	5245
AVERAGE R 1	722.50	699.38	684.38	655.63
R 2	710	900	630	580
	750	675	655	725
	835	780	760	675
	650	740	645	735
	750	670	665	725
	655	620	740	580
	640	535	700	590
	750	725	655	490
SUM R 2	5740	5645	5450	5100
AVERAGE R 2	717.50	705.63	681.25	637.50
R 3	645	685	755	670
	740	720	825	740
	655	815	685	600
	640	735	615	750
	630	625	570	510
	735	750	710	670
	790	550	595	720
	685	745	725	740
SUM R 3	5520	5625	5480	5400
AVERAGE R 3	690.00	703.13	685.00	675.00
R 4	630	685	565	750
	810	745	665	695
	695	775	720	595
	790	630	665	745
	510	735	720	605
	720	655	685	650
	810	710	745	660
	595	640	655	760
SUM R 4	5560	5575	5420	5460
AVERAGE R 4	695	696.875	677.5	682.5
AV. OF TRT	706.25	701.25	682.03	662.66

Table 2. Body weights of individual birds of the 4 treatments at end of week 4

Replicate	1	2	3	4
R 1	1140	945	1330	1130
	1090	1460	1180	1005
	1085	1015	970	870
	1175	1115	990	1355
	920	905	995	880
	945	980	985	1070
	1150	960	1285	1125
	965	1265	1225	885
SUM R 1	8470	8645	8960	8320
AVERAGE R 1	1058.75	1080.63	1120.00	1040.00
R 2	1160	1235	1080	975
	1240	1085	1070	1000
	1090	985	1065	860
	1095	1235	1050	1105
	1210	1425	1035	880
	1425	970	1075	1080
	1015	1195	975	1145
	1215	1020	1075	1100
SUM R 2	9450	9150	8425	8145
AVERAGE R 2	1181.25	1143.75	1053.13	1018.13
R 3	1080	1210	1255	1220
	925	1165	1365	875
	1110	1000	1165	1190
	1185	1400	1110	1290
	1215	1210	1220	1285
	1240	1020	1120	1030
	1240	1110	1095	1340
	1330	890	1215	1005
SUM R 3	9325	9005	9545	9235
AVERAGE R 3	1165.63	1125.63	1193.13	1154.38
R 4	1280	1345	1240	1155
	1370	990	1130	1195
	1135	1085	1190	880
	1270	1125	1300	1280
	1375	1025	1155	980
	1220	1110	1085	1185
	960	1100	1160	1175
	800	1140	1115	1000
SUM R 4	9410	8920	9375	8850
AVERAGE R 4	1176.25	1115	1171.875	1106.25
AV. OF TRT	1145.47	1116.25	1134.53	1079.69

Table 3. Body weights of individual birds of the 4 treatments at end of week 5

Replicate	1	2	3	4
R 1	1779	1774	1667	1515
	1810	2073	1403	1702
	1460	1346	1547	1404
	1581	1340	1631	1682
	1709	1436	1319	1480
	1670	1841	2076	1433
	1642	1515	1828	1244
	1281	1340	1514	1865
SUM R 1	12932	12665	12985	12325
AVERAGE R 1	1616.50	1583.13	1623.13	1540.63
R 2	1723	1760	1598	1399
	1537	1758	1477	1643
	1739	1548	1580	1628
	1390	1946	1537	1293
	1525	1643	1520	1404
	1985	1489	1414	1225
	1655	1470	1554	1484
	1586	1532	1470	1375
SUM R 2	13140	13146	12150	11451
AVERAGE R 2	1642.50	1643.25	1518.75	1431.38
R 3	1506	1624	1712	1483
	1429	1791	1653	1626
	1626	1587	1721	1264
	1546	1625	1714	1810
	1440	1456	1624	1551
	1680	2149	1665	1819
	1885	1470	1675	1432
	1918	1363	1476	1365
SUM R 3	13030	13065	13240	12350
AVERAGE R 3	1628.75	1633.13	1655.00	1543.75
R 4	1807	1365	1751	1574
	1287	1550	1643	1479
	1785	1820	1517	1745
	1890	1510	1600	1710
	1640	1590	1580	1601
	1257	1363	1652	1501
	1572	1653	1609	1312
	1487	1589	1533	1278
SUM R 4	12725	12440	12885	12200
AVERAGE R 4	1590.625	1555	1610.625	1525
AV. OF TRT	1619.59	1603.63	1601.88	1510.19

Table 4 Average feed intake/bird for the replicates of the 4 treatments at different periods.

age 0 -3weeks (for period 0 - 2 wks = 476gms/bird)

Replicates	1	2	3	4
r 1	1041	1043.5	1039.13	1038.5
r 2	1046	1069.75	1014.75	987.88
r 3	1032.25	1046	1022.25	1012.88
r 4	1021.63	1052.25	1041	1014.13
average of trt	1035.22	1052.875	1029.2825	1013.3475

age 0 - 4 wks

Replicates	1	2	3	4
r 1	1780.4	1864.8	1914.8	1847.3
r 2	1848.5	1940.4	1838.5	1869.8
r 3	1853.5	1883.5	1875.4	1924.1
r 4	1884.8	1883.5	1934.13	1940.4
average of trt	1841.8	1893.05	1890.7075	1895.4

age 0 - 5 wks

Replicates	1	2	3	4
r 1	2909.2	3001.1	3029.8	2976
r 2	2957.9	3044.2	2928.5	2881
r 3	2902.9	2966	2963.5	2960.4
r 4	3002.3	2963.5	3011.6	3059.8
average of trt	2943.075	2993.7	2983.35	2969.3

Table 5. Feed conversion ratio for replicates of the 4 treatments.

Replicate	control	Treatment 1	Treatment 2	Treatment 3
r 1	1.800	1.896	1.867	1.932
r 2	1.801	1.853	1.928	2.013
r 3	1.782	1.816	1.791	1.918
r 4	1.887	1.906	1.870	2.006
average of trt	1.818	1.868	1.864	1.967

Table 6. Average daily feed intake/bird for different weeks

(For periods 0-2 weeks intake = 476 gm/bird)

week 3

Replicates	control	trt1	trt 2	trt 3
r 1	80.71	81.07	80.45	80.36
r 2	81.43	84.82	76.96	73.13
r 3	79.46	81.43	78.04	76.70
r 4	77.95	82.32	80.71	76.88
average of trt	79.89	82.41	79.04	76.76

week 4

Replicates	control	trt1	trt 2	trt 3
r 1	105.63	117.33	125.10	115.54
r 2	114.64	124.38	117.68	125.99
r 3	117.32	119.64	121.88	130.17
r 4	123.31	118.75	127.59	132.32
average of trt	115.23	120.03	123.06	126.01

week 5

Replicates	control	trt1	trt 2	trt 3
r 1	161.26	162.33	159.29	161.24
r 2	158.49	157.69	155.71	144.46
r 3	149.91	154.64	155.44	148.04
r 4	159.64	154.29	153.92	159.91
average of trt	157.33	157.24	156.09	153.41

experimental period (weeks 3 - 5)

Replicates	control	trt1	trt 2	trt 3
r 1	115.87	120.24	121.61	119.05
r 2	118.19	122.30	116.79	114.52
r 3	115.57	118.57	118.45	118.30
r 4	120.30	118.45	120.74	123.04
average of trt	117.48	119.89	119.40	118.73

total rearing period (0 - 5 weeks)

Replicates	control	trt1	trt 2	trt 3
r 1	83.12	85.75	86.57	85.03
r 2	84.51	86.98	83.67	82.31
r 3	82.94	84.74	84.67	84.58
r 4	85.78	84.67	86.05	87.42
average of trt	84.09	85.53	85.24	84.84

Table 7. Average daily gain/bird for different weeks.

week 3

Replicates	1	2	3	4
r 1	52.79	49.48	47.34	43.23
r 2	52.07	50.38	46.89	40.64
r 3	48.14	50.02	47.43	46.00
r 4	48.86	49.13	46.36	47.07
average of trt	50.46	49.75	47.00	44.24

week 4

Replicates	1	2	3	4
r 1	48.04	54.46	62.23	54.91
r 2	66.25	62.59	53.13	54.38
r 3	67.95	60.36	72.59	68.48
r 4	68.75	59.73	70.63	60.54
average of trt	62.75	59.29	64.64	59.58

week 5

Replicates	1	2	3	4
r 1	79.68	71.79	71.88	71.52
r 2	65.89	71.36	66.52	59.04
r 3	66.16	72.50	65.98	55.63
r 4	59.20	62.86	62.68	59.82
average of trt	67.73	69.63	66.76	61.50

experimental period (weeks 3 - 5)

Replicates	1	2	3	4
r 1	60.17	58.58	60.48	56.55
r 2	61.40	61.44	55.51	51.35
r 3	60.75	60.96	62.00	56.70
r 4	58.93	57.24	59.89	55.81
average of trt	60.31	59.55	59.47	55.10

total rearing period (0 - 5 weeks)

Replicates	1	2	3	4
r 1	45.03	44.08	45.22	42.86
r 2	45.77	45.79	42.24	39.74
r 3	45.38	45.50	46.13	42.95
r 4	44.29	43.27	44.86	42.41
average of trt	45.12	44.66	44.61	41.99

Table 8. Percent of organs to live weight for treatment1 (control).

Description	R 1	R 2	R 3	R 4	AVERAGE
live wt	1492	1423	1437	1539	1472.75
carcass	56.836	59.452	60.891	61.339	59.633
Gizzard	2.279	2.530	2.296	2.859	2.495
Liver	3.284	2.741	2.505	2.404	2.733
Heart	0.737	0.773	0.626	0.520	0.662
Esophagus	0.268	0.351	0.278	0.195	0.272
Crop	0.268	0.351	0.278	0.325	0.306
Lungs	0.536	0.632	0.696	0.520	0.594
Trachea	0.201	0.351	0.278	0.195	0.255
Proventiculus	0.804	0.632	0.696	0.780	0.730
small intestine	5.831	5.060	4.593	4.483	4.991
large intestine	0.268	0.211	0.278	0.260	0.255
cecum	0.737	0.703	0.765	0.585	0.696
thighs	17.493	17.850	18.928	16.959	17.790
thighs meat	14.142	14.617	15.310	13.385	14.344
thighs bone	3.351	3.233	3.619	3.574	3.446
breast	17.895	20.239	19.346	21.183	19.674
breast meat	16.086	18.412	17.189	18.908	17.654
breast bone	1.810	1.827	2.157	2.274	2.020
neck	4.223	3.584	3.827	3.574	3.802
wings	6.233	7.309	6.959	6.888	6.841
back	10.992	10.471	11.830	12.736	11.526
feet	4.357	4.216	3.967	3.574	4.023
head	2.011	2.108	2.157	1.949	2.054
dig.tract+ content	19.973	18.271	17.954	17.349	18.384

Table 9. Percent of organs to live weight for treatment 2 (5 % citrus pulp).

Description	R 1	R 2	R 3	R 4	AVERAGE
live wt	1446	1429	1380	1461	1429.00
carcass	57.261	58.922	60.507	60.575	59.307
Gizzard	2.766	2.659	2.609	2.464	2.624
Liver	2.628	2.589	3.188	2.669	2.764
Heart	0.484	0.630	0.580	0.684	0.595
Esophagus	0.277	0.350	0.290	0.205	0.280
Crop	0.415	0.420	0.435	0.411	0.420
Lungs	0.415	0.420	0.290	0.479	0.402
Trachea	0.138	0.210	0.145	0.137	0.157
Proventiculus	1.314	1.050	0.580	0.479	0.857
small intestine	5.671	5.038	4.710	4.586	5.003
large intestine	0.277	0.280	0.145	0.342	0.262
cecum	0.692	0.770	0.580	0.684	0.682
thighs	17.566	17.215	17.681	17.796	17.565
thighs meat	14.108	13.366	13.841	13.552	13.716
thighs bone	3.458	3.849	3.841	4.244	3.849
breast	17.566	20.084	19.638	21.150	19.612
breast meat	15.491	17.775	17.319	19.233	17.460
breast bone	2.075	2.309	2.319	1.916	2.152
neck	4.288	3.779	4.203	3.765	4.006

wings	6.501	7.908	7.464	6.845	7.173
back	11.342	9.937	11.522	11.020	10.952
feet	3.665	3.359	4.130	3.628	3.691
head	2.075	2.169	2.174	1.916	2.082
dig.tract+ content	19.364	21.064	19.275	18.138	19.454

Table 10. Percent of organs to live weight for treatment 3 (7.5 % citrus pulp).

Description	R 1	R 2	R 3	R 4	AVERAGE
Live wt	1741	1214	1359	1430	1436.00
carcass	61.459	58.814	59.971	57.203	59.488
Gizzard	2.240	2.554	2.134	2.238	2.281
Liver	2.814	2.801	3.238	3.427	3.064
Heart	0.517	0.659	0.809	0.629	0.644
Esophagus	0.230	0.247	0.294	0.280	0.261
Crop	0.345	0.165	0.294	0.350	0.296
Lungs	0.517	0.577	0.442	0.629	0.540
Trachea	0.287	0.247	0.147	0.140	0.209
Proventiculus	0.747	0.659	0.589	0.769	0.696
small intestine	5.399	5.189	5.077	5.524	5.310
large intestine	0.230	0.329	0.368	0.280	0.296
cecum	0.689	0.659	0.589	0.699	0.662
thighs	19.644	17.710	19.868	17.483	18.750
thighs meat	15.566	13.509	15.453	13.706	14.641
thighs bone	4.078	4.201	4.415	3.776	4.109
breast	19.759	18.204	17.145	18.531	18.506
breast meat	17.634	15.733	14.790	16.434	16.260
breast bone	2.125	2.471	2.355	2.098	2.246
neck	4.308	4.778	3.900	3.916	4.213
wings	7.639	7.908	8.094	6.643	7.556
back	10.109	10.214	10.964	10.629	10.463
feet	4.078	4.448	4.415	4.126	4.248
head	1.895	2.554	2.281	2.308	2.228
dig.tract+ content	17.806	18.946	19.132	22.378	19.499

Table 11. Percent of organs to live weight for treatment 4(10 % citrus pulp).

Description	R 1	R 2	R 3	R 4	AVERAGE
live wt	1543	1322	1538	1342	1436.25
carcass	60.920	61.952	60.468	60.581	60.957
Gizzard	2.787	3.328	2.926	3.428	3.272
Liver	2.722	3.026	2.731	2.906	2.837
Heart	0.648	0.756	0.520	0.596	0.627
Esophagus	0.194	0.303	0.195	0.149	0.209
Crop	0.324	0.303	0.390	0.373	0.348
Lungs	0.518	0.530	0.390	0.596	0.505
Trachea	0.194	0.151	0.195	0.149	0.174
Proventiculus	0.778	0.681	0.650	0.745	0.714
small intestine	4.472	5.144	5.072	5.589	5.048
large intestine	0.259	0.303	0.325	0.298	0.296
cecum	0.518	0.530	0.650	0.447	0.540

thighs	18.665	19.289	17.815	17.958	18.416
thighs meat	14.323	15.280	14.369	13.785	14.430
thighs bone	4.342	4.009	3.446	4.173	3.986
breast	20.415	19.516	21.066	21.237	20.574
breast meat	18.082	17.474	18.791	18.703	18.277
breast bone	2.333	2.042	2.276	2.534	2.298
neck	3.953	4.236	4.681	3.577	4.125
wings	7.259	7.186	6.957	7.973	7.328
back	10.629	11.725	9.948	9.836	10.513
feet	3.824	4.085	3.901	4.471	4.056
head	2.463	2.421	2.276	2.310	2.367
dig.tract+ content	19.831	18.381	18.140	20.268	19.147

Table 12. Lengths of some gastrointestinal tract parts of different treatments.

Treatment 1

	Replicate 1	Replicate 2	Replicate 3	Replicate 5	Average
s. intestine length	241	235	220	216	228.00
l. intestine length	10	9.5	10.5	9.8	9.95
cecum length	25	23	23.5	25	24.13
Esophagus length	10.5	10	10.3	11	10.45

Treatment 2

s. intestine length	250	264	264	250	257.00
l. intestine length	12	11	13	12.5	12.13
cecum length	21	29	26	23.5	24.88
Esophagus length	10	10.5	11.5	9.5	10.38

Treatment 3

s. intestine length	248	233	240	245	241.50
l. intestine length	10.5	10.5	11	10	10.50
cecum length	25.5	23	23.5	28	25.00
Esophagus length	12	11	9.5	11.5	11.00

Treatment 4

s. intestine length	232	226	228	247	233.25
l. intestine length	11	10.5	11.5	10	10.75
cecum length	24	24	28.5	24.5	25.25
esophagus length	9.5	10	9	9.5	9.50

جامعة النجاح الوطنية
كلية الدراسات العليا

استخدام مخلفات عصر الحمضيات في صناعة علائق الدجاج اللاحم

اعداد
زهدي فتحي زهدي الخواجة

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قدمت هذه المطروحة استكمالا لمتطلبات درجة الماجستير في العلوم البيئية بكلية الدراسات العليافي جامعة النجاح الوطنية في نابلس، فلسطين.

٢٠٠٣

الملخص

اجريت هذه الدراسة لمعرفة أثر استخدام مخلفات الحمضيلت في العلف على أداء الصيصان اللاحمة، وقد استخدم فيها ١٥٠ صوص عمر يوم تم تربيتها كأي قطيع تجاري حتى عمر ١٤ يوم على علف بادىء. بعدها تم أخذ ١٢٨ طير متوسط الحجم وتقسيمها الى اربعة مجموعات متساوية الوزن وكل مجموعة الى اربع مكررات متساوية الوزن وتم تربيتها على مساحة ارض مناسبة. وتم استبدال الذرة في النهائي (من عمر ١٥ – ٣٥ يوم) بنسبة ٥ و ٧.٥ و ١٠% بمخلفات الحمضيات المجففة والتي كان قد تم جمعها بعصر وطحن وتجفيف ثم طحن ثمار البرتقال من السوق المحلي. ثم أخذ الوزن لكل صوص واستهلاك العلف لكل مكرر بشكل اسبوعي وفي نهاية التجربة تم أخذ أربعة صيصان في كل مجموعة و ذبحها كما هو متعارف رتم وزن الاحشاء والاعضاء الداخلية وأطوال الجهاز الهضمي وأجزاءه ، وكذلك وزن قطع الذبائح.

بينت التجربة أنه يمكن استخدام مخلفات الحمضيات حتى ٧.٥% من العلف دون أي أثر على الدجاج أو استهلاك العلف. لكن عند استخدام ١٠% كانت الزيادة الوزنية هي الأقل أما التأثير على أجزاء الذبيحة والأحشاء والجهاز الهضمي فلم يكن واضحاً ($P<0.05$) . أظهرت الدراسة إمكانية استخدام مخلفات الحمضيات في تربية الدجاج اللاحم وإن هذه المخلفات يمكن استخدامها كمصدر علف بديل للتقليل من كلفة الانتاج وفي نفس الوقت التخلص من المخلفات بطريقة مجدية بدلاً من إلقائها كمخلفات تلوث البيئة .