



Response of New Zealand Rabbits to Diet Containing Guava Waste (*Psidium Guajava L.*): 1. Effect on Growth Performance, Diet Digestibility and Economic Efficiency

Eman Ramadan Kamel¹, Fathy Abdel-Fattah², Hadeel Samy El-Qaliouby¹ and Mahmoud .E.A.A³

¹Department of Animal Wealth Development, Faculty of Veterinary Medicine, Benha University, Moshtohor, Toukh 13736, Qalyubia, Egypt.

Department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, Benha University, Moshtohor, Toukh 13736, Qalyubia, Egypt.

³ Department of Animal Hygiene, Behaviour and Management, Faculty of Veterinary Medicine, Benha University, Moshtohor, Toukh 13736, Qalyubia, Egypt.

ABSTRACT

Key words:

Guava waste, organic acids, rabbit, mannan oligosaccharide, growth, digestibility.

Forty eight New Zealand White weaned male rabbits (28 d of age) were classified into 4 groups (12/group). Four isonitrogenous, iso-energetic and isofibrous diets were formulated. The control diet was based on corn, soybean and straw. Guava waste (GW) was collected, dried and crushed as meal, then chemically analyzed. Three diets (D1, D2 and D3) were prepared to contain 20% dried GW meal. Diets D2 and D3 were supplemented by 1% of either a blend of organic acids or Mannan oligosaccharide (MOS), respectively. Diets and water were offered *ad-libitum* to rabbits and feed intake was recorded daily. Body weight change was recorded weekly and. Digestibility trial was carried out at 46 d of age by fecal collection for 4 successive days and followed by feed and feces analysis. The digestion coefficients were calculated for organic matter (OM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF), and non fiber carbohydrate (NFC). At 98 d of age, blood samples were collected after slaughter for hematology and carcass dressing measurements. Results revealed that GW was rich in crude fiber but its inclusion in the diet improved significantly ($P<0.05$) OM and nutrients digestibility, feed conversion ratio (FCR), and performance index (PI) of rabbits fed diets D1, D2 and D3 when compared with the control group. Organic acids and MOS supplementation to diets D2 and D3 improved the efficiency of feed digestibility and growth. Results of blood and carcass traits showed no adverse effect of GW inclusion in the diet of rabbits. Economically, inclusion of GW either alone in the diet or with MOS supplementation was the most profitable when compared with other diets. In conclusion, GW can be satisfactory added to diets of growing rabbits without negative effect on growth, digestibility, health and carcass characteristics, and economizes feed costs and preserves the environment by reduction of pollution caused by its processing and manufacturing.

Corresponding Author: **Eman R. Kamel**: eman.ramadan05@yahoo.com

1. INTRODUCTION

Guava (*Psidium guajava Linn*) is cultivated in tropical and subtropical areas of many countries. It belongs to family of *Myrtaceae*, genus: *Psidium*, species: *Guajava* and the common name is guava (Mathew et al., 2014). The fruit contains a fleshy pericarp and pulp with multiple small seeds. It is processed for human nutrition as beverages, puree, jam, canned slices, syrup concentrate and juices. The total world production for mangoes, mangosteens and guava was more than 43 million tons and the production quantity was estimated in Egypt as 834.543 tons by the year 2013 (FAOSTAT, 2014). Guava waste (GW) constitutes 4% to 12% of the total mass of the fruit (Uchôa-

Thomaz et al., 2014). These waste materials are considered an ecological problem due to accumulation of large and useless quantities.

Nutrition is the key determinant of sustainability and economic viability of the livestock farming (Kannan et al., 2005). In our countries, increasing the price of conventional feed ingredients and their shortage are the major problems affecting development of rabbits and poultry industry (EL-Manylawi, 2011). Therefore, recent studies focused on the use of agriculture and food processing wastes in animals and poultry feeding. GW contains fibrous components such as stone cells, and seeds. It contains 7.6% protein, 16.0% fat, 61.4% fiber, and 0.93% ash (Prasad and

Azeemoddi, 1994; Khalifa, 2014). Dried guava pomace consisted of about 94% seeds and 6% skins (Bernardino Nicanor et al., 2000; and Denny et al., 2013). Due to the high fiber content of GW, it could be used in rabbit diets. Rabbits require a high-fiber diets when compared with other simple stomach animals and poultry. They are hind-gut fermenters and are capable of retaining small fiber particles for digestion (EL-Manyawi, 2011). An extensive research work has been done on the nutritive value and biological activity of guava peel, flesh and leaves (Gutiérrez et al. 2008; Labibah, 2009 and Sanda et al, 2011). Few experiments were carried out on the use of GW as a feed ingredient in rabbit nutrition. Also it has been proven in many research works that prebiotics and organic acids supplementation to diet could support digestion and/or metabolism by animal through their action on intestinal microflora. The use of these additives is based on safety and probability to be of great economic importance (Hassanein et al., 2002).

Therefore, this study was carried out to investigate the response of growing New Zealand rabbits to diet containing dried GW, with or without supplementation of either prebiotic or mixture of organic acids. The evaluated parameters are growth performance, apparent diet digestibility, some blood constituents, carcass characteristics, and economic efficiency.

2. MATERIALS AND METHODS

The experiment was conducted at the rabbit production unit of the faculty of veterinary medicine, Benha University. The experimental period was 9 weeks, from 7th January to 10th of March.

2.1. Animals and housing management:

A total of 48 New Zealand White male rabbits weaned at 28 d and weighed on an average (448±13.5 g) obtained from commercial rabbit farms in Qalyubia Governorate. Animals were randomly assigned to 4 experimental groups (12 rabbits/group) and housed in pairs in 24 wire mesh cages measuring 60×40×35 cm (length x width x height). The cages were equipped with hopper feeders and nipple drinkers. Clean and fresh drinking water was offered all times. Rabbits were reared in a closed room with mean temperature and humidity ranging from 14 to 20°C and from 59 to 65%, respectively with only natural light during the day.

2.2. Diet and experimental design:

GW was collected from Vitrac[®] Company for food processing, Qalyubia, EGYPT. It was dried in oven at 60°C for 48 hr. The dried GW was crushed, well mixed and stored in a well-ventilated place. Sample of GW was chemically analyzed for composition according to AOAC, (1995). Diets were formulated (Table 1) as iso-nitrogenous, iso-energetic and iso-fibrous according to the nutrient requirements (NRC of rabbits, 1977 and De Blas & Weiseman 2010). The basal diet (Control, C) was formulated mainly from corn, soybean meal, molasses and fennel straw. Three diets (D1, D2 and D3) were formulated to contain 20% GW. The diets D2 and D3 were supplemented with either 1.0% Y-MOS[®] (MOS plus β-glucan, Nutrex, Belgium) or 1.0% Fylax forte[®] (Synergistic mixture of organic acids, ammonium propionate, toxin binder, and other supporting ingredients (water-binding agents, surfactants and ingredients preventing evaporation, Selko, Netherlands). All experimental diets were fortified with a constant level of salt and vitamin-mineral premix. Diet pellets were prepared (4 mm diameter, 9 mm length) in a commercial feed mill for rabbits.

After one week accommodation period, rabbits were fed *ad-libitum* on 4 different experimental diets until the end of the experiment (98 d of age). During the experimental period, the feed intake was recorded daily. Rabbits were weighed weekly at the same time in the morning and daily weight gain was subsequently calculated. Feed conversion ratio (FCR) was computed using the formula:

$$[\text{FCR} = \frac{\text{Mass of food consumed (dry)}}{\text{Increase of mass of animal produced (wet)}} \text{ (Cheeke, 1987)}].$$

While the performance index (PI) was calculated by the formula:

$$[\text{PI} = \frac{\text{Final body weight (kg)}}{\text{FCR}} \times 100 \text{ (North, 1981)}].$$

2.3. Body Weight Gain (BWG): The gain in body weight per week was obtained by calculating the difference between two successive weights (Mohamed, 2014).

Table 1. Composition and calculated analysis of the experimental diets

	Control	D1	D2	D3
Feed ingredients (% as fed)				
GW	00.00	20.00	20.00	20.00
Yellow corn	35.00	25.00	25.00	25.00
Soybean meal (44%CP)	31.20	24.60	24.60	24.60
Wheat bran	00.00	24.00	23.90	23.90
Fennel straw	28.00	00.00	00.00	00.00
Molasses	02.00	02.00	02.00	02.00
Y-MOS	00.00	00.00	00.10	00.00
Fylax	00.00	00.00	00.00	00.10
DL-Methionine	00.40	00.40	00.40	00.40
L- Lysine	00.00	00.10	00.10	00.10
Vita. &Min. mix. ¹	00.50	00.50	00.50	00.50
Salt	00.50	00.50	00.50	00.50
Limestone	01.10	02.90	02.90	02.90
Dicalcium phosphate	01.30	00.00	00.00	00.00
Total	100.00	100.00	100.00	100.00
Calculated chemical composition (%)²:				
Crude protein %	18.00	18.03	18.01	18.01
Crude fiber %	14.86	16.46	16.45	16.45
NDF % ³	38.68	39.73	39.73	39.73
ADF % ⁴	22.98	24.44	24.43	24.43
Calcium %	1.20	01.21	01.21	01.21
Total phosphorus %	0.61	00.65	00.65	00.65
Lysine %	0.91	00.81	00.81	00.81
Methionine + Cystine %	0.68	00.61	00.61	00.61
Digestible energy (kcal/kg)	2529.40	2596.29	2593.80	2593.80

¹Purchased by Oynx Veta for Veterinary products, Mehalla Road, Tanta city, Egypt. Mineral and vitamin premix composition (per 3kg): Vitamin A = 12,000,000 IU, D₃ = 2,000,000 IU, E = 10,000 mg, K₃ = 1,000 mg, B₁ = 1,000 mg, B₂ = 5,000 mg, B₆ = 1,500 mg, B₁₂ = 10 mg, Niacin = 30,000 mg, Biotin = 50 mg, Folic acid = 1,000 mg, Pantothenic acid = 10,000 mg, Choline chloride = 500,000 mg, Zinc = 50,000 mg, Manganese = 60,000 mg, Iron = 30,000 mg, Copper = 10,000 mg, Iodine = 1,000 mg, Selenium = 100 mg, Cobalt = 100 mg, Calcium carbonate to 3kg.

²According to Feed Composition Tables for rabbits (*NRC rabbit 1977, de Blas & Weiseman 2010*).

³Neutral detergent fiber (NDF%) = 28.924 + (0.657*CF %), ⁴Acid detergent fiber (ADF%) = 9.432 + (0.912*CF %) (*Cheeke 1987*).

2.4. Digestibility trial:

The digestibility trial of each dietary treatment (12 rabbits) was carried out according to Perez *et al.* (1995). The daily feed intake was recorded. After an adaptation period of 7 days, the hard fecal output was collected in polyethylene bags for consecutive 4 days between 46 to 50 d of age at the same time in the morning and stored at -18°C. Fecal samples (100 g) from each test group were partially dried at 80°C for 48 h and used latter for chemical analysis. Feed and fecal samples from experimental groups were chemically analyzed according to AOAC (1995). Dry matter (DM) was measured using hot air circulation oven (Heraeus Ut20, Germany) at 105 °C for 3 hours. Crude protein (CP) was measured using Kjeltex system 2100-FOSS, Sweden. Ether Extract (EE) was determined by Soxtec system 2045, FOSS-Sweden), and Ash (Furance 6000, thermolyne, USA), while the non fiber carbohydrates (NFC) concentration was calculated according to Calsamiglia *et al.* (1995) using the

following equation: $NFC = 100 - (CP + NDF + EE + ash)$. NDF and ADF were determined using the method of Van Soest *et al.*, (1991). The coefficient of dietary apparent digestibility is determined for Organic matter (OM), NDF, ADF, CP, EE, and NFC from each dietary treatment. Digestibility coefficient was calculated according to the formula proposed by Crampton and Harris (1969):

Apparent Digestibility

$$= \frac{[(\% \text{Nutrients in feed} \times \text{FI}) - (\% \text{Nutrients in faeces} \times \text{FO})]}{[\% \text{Nutrients in Feed}]}$$

Where: FI= feed intake, FO=fecal output

2.5. Blood analysis and carcass traits:

At the end of experiment, rabbits (10/group) were weighed in the slaughter house of research center in the faculty of Veterinary Medicine, Benha

University, slaughtered by cutting carotid arteries and jugular veins after neck hitting. Two blood samples were collected from jugular vein during bleeding. The first one was taken on EDTA for hematological parameters, while the second one was collected in plain tubes and centrifuged at 3000 rpm (Sigma 3-18K) for serum separation then stored at -20°C until used for biochemical analyses. AST and ALT were measured according to (Henry (1964), total protein and albumin were determine according to Belfield and Goldberg (1971) and urea and creatinine according to Husdan and Rapaport (1968). The hematological parameters comprised the count of red blood cells (RBCs), white blood cells (WBCs), and differential leukocytes. Determination of packed cell volume (PCV) and hemoglobin (Hb) contents were conducted according to Feldman et al., (2000).

For carcass traits, the skin, paws, gut, urinary bladder, and genital organs were weighed separately and removed. After 30 min of slaughter, weights of hot carcass including head, liver, kidneys, and thoracic viscera (heart, lungs, esophagus, trachea and thymus) were recorded (Blasco and Ouhayoun, 1993). The hot carcass percentage was calculated according to Daszkiewicz et al., (2003). The stomach and intestine as well as skin percentages were computed in relative to live weight at slaughter. The organs (heart, liver, kidneys, lungs, and head) were calculated as percentage of hot carcass weight.

2.6. Economic efficiency:

The costs of production were calculated in two items; firstly, the total variable costs (TVC) including the price of purchased rabbits, feed costs (feed ingredients, GW, Y-MOS, Fylax forte) for each experimental diet (Shreya et al., 2014). They were estimated for each rabbit by Egyptian pound over the course of the experiment. The total fixed costs (TFC) were calculated for labor, litter, drugs, disinfectants, veterinary supervision, water, electricity and miscellaneous cost, in addition to the building rent value. Hence, all of these parameters were considered fixed costs for each rabbit used in this study (Ani and Ugwuowo, 2011). The equipment depreciation was calculated as the value of equipment (L.E) for project cycles per number of years divided by the total number of rabbits

(Sankhyan, 1983). Finally, the total costs (TC) were estimated by summation of TFC and TVC values according to Atallah, (1997). Secondly, the returns parameters were computed as the total returns (TR) and net profit (NP). The TR was the sum of the sale price of kg of rabbits and fecal matter (Mohamed, 2014). The NP was calculated as TR minus TC (Fardoos, 2009). The economic efficiency measurements were estimated according to Atallah, (2004). They included percentages of Total Return /Total Cost (TR/TC), Net Profit /Total Cost (NP/TC) and Net Profit /Total Return (NP/TR).

2.7. Statistical analyses:

Differences between studied groups were analyzed by the Statistical Analysis System (SAS, 2003) Computer Program, using the General Linear Model (GLM) procedure and Duncan's Multiple Range-Test (Duncan, 1955). Statistical significance between mean values was set at ($P < 0.05$). Data are reported as means and standard error of mean (SEM). Figures were performed by using Microsoft Office Excel, (2007).

2. RESULTS AND DISCUSSION

3.1. GW proximate analysis:

Analysis and composition of GW are not available in the feed composition tables of rabbit nutrition. GW proximate analysis (Table 2) revealed that CP content was nearly similar to results of other researchers (Lira *et al.*, 2011; El Deek *et al.*, 2009a; Santos *et al.*, 2009; and Silva, 1999) that ranged from 8.6% to 10.09%. The content of ether extract (EE) was higher than the range of results of the same authors (from 9.69% to 11.68%). Crude fiber (CF) content of GW was close to the range 56.01% to 60.08% (Lira *et al.*, 2011), but was different from the range of 39.5% to 46.88% (El Deek *et al.*, 2009a; Santos *et al.*, 2009). For ash content, it was lower than that of the same researchers (2.21%-2.52%). These variations in composition of GW between literatures may be attributed to either the presence of different varieties of the plant which is cultivated in many different areas of the world or due to variation in processing methods. In this respect, Mohamed *et al.* (1971) found that the values of proximate analysis of date stones were affected by the processing methods.

Table 2: Proximate analysis (as fed basis) of GW (*Psidium guajava* L.)

GW (<i>Psidium guajava</i> L.)	
DM	94.35
CP	7.53
EE	18.93
CF	59.21
Ash	1.27
NFE	7.41
Digestible energy* (DE, Kcal/kg)	2012

*DE was calculated according to Fekete and Gippert (1986) as:

DE (kcal/kg DM): 4253–32.6 (Crude fiber % DM) – (144.4×Ash % DM).

Table 3: Growth performance of growing rabbits fed the experimental diets

	Control	D1	D2	D3	SEM*
Total feed intake (g):	6947.9 ^b	6351.6 ^a	6254 ^a	6455.3 ^a	84.3
Daily Feed intake (g):	110.3 ^b	100.8 ^a	99.3 ^a	102.5 ^a	1.81
Initial weight (g):	434.6	425.4	434.17	450.4	12.13
Final weight (g):	1965.8 ^b	2168.7 ^a	2285.4 ^a	2235 ^a	32.6
BWG (g):	1531.2 ^b	1743.3 ^a	1851.25 ^a	1784.6 ^a	29.43
Average daily gain (g):	24.3 ^b	27.7 ^a	29.01 ^a	28.3 ^a	0.45
FCR	4.53 ^b	3.94 ^a	3.52 ^a	3.72 ^a	0.105
PI	47.4 ^b	63.4 ^a	66.02 ^a	59.7 ^a	2.09

*SEM - Standard Error of Mean

^{ab}Within rows means bearing different superscripts differ significantly at P<0.05.

3.2. Growth performance and feed efficiency:

The indices of growth performance for growing rabbits fed diets D1, D2 and D3 were significantly ($P<0.05$) better than that of control diet (Table 3). Although the diet was formulated to contain nearly the same level of crude fiber for all experimental groups, there was a significant higher feed intake for control group than others. It was indicated that the increased feed intake for control group was not reflected on growth parameters. The total and daily body weight gains (BWG) (Table 3 and Figure 1) were significantly ($P<0.05$) better in D1, D2 and D3 than control group. The only difference is the inclusion of GW in the three diets (D1, D2 and D3) instead of fennel straw in the control diet. This may be explained as GW contained more digestible fiber than that of fennel straw. This was clear in the results of digestion coefficient of dietary NDF and ADF (Table 4). It was found that using soluble and fermentable fiber in rabbits diet lowers caecal pH and increases level of volatile fatty acids (Alvarez *et al.*, 2007), reduces pathogenic flora (De Blas *et al.*, 2002), increases the total retention time with improving nutrient's absorption and consequently decreases feed intake and improve growth performance (García *et al.*, 1993, Carabaño *et al.*, 1997; Falcao-e-Cunha *et al.*, 2004).

Rabbits fed diets containing only 20% GW (D2) showed better performance (BWG, FCR and

PI than control group (Table 3). This may be attributed to its content of antioxidant vitamin C (Bikrisima *et al.*, 2014), it was found that performance of broiler chickens was improved by inclusion of guava by-product in the diet. In other experiments (Marquina *et al.* 2008 and El Deek *et al.*, 2009b) it was indicated that feeding sun dried or processed guava by-products (GBP) to laying hens helped keeping the quality of egg number, egg mass, egg weight and shell due to antioxidant potency of Vitamin C in GW (Holland *et al.*, 1991) and the antioxidant dietary fiber (AODF) with methoxylated pectin (Uddin *et al.*, 2002). Also GW contains a good profile of amino acids, mainly arginine, glutamic acid, aspartic acid, glycine and leucine (Habib, 1986) with 12 fatty acids improve its nutritive value for feeding (Opote, 1978 and Aly 1981). Furthermore, the synergic effect of EE and CF in GW have improved the gastrointestinal transit and consequently improved BWG (Lira *et al.*, 2009). For FCR and PI in Table 3, there was significant improvement ($P<0.05$) for rabbits fed diet D2 when compared with the control diet and insignificantly with D1 and D3. Y-MOS[®] is composed mainly of 27% MOS and 18% β -Glucan. MOS is derived naturally from cell wall of the yeast *Saccharomyces cerevisiae* by centrifugation of lysed yeast culture (Spring *et al.*, 2000).

The effect of MOS may be attributed to improvement of intestinal morphology, nutrient digestibility and increased length of ileal villi (Mourão *et al.*, 2006). The mode of action of MOS is firstly; by attaching undesirable microorganisms preventing them from connection to the intestinal mucosa and competing with its sugar receptors. Secondly; MOS stimulates of the intestinal immune system. This action improves the growth of beneficial microbes; enhances diet digestion and absorption and consequently improves performance (Falcão-e-Cunha *et al.*, 2007).

β -glucan has been purified from brewer's and baker's yeast (Tokunaka *et al.*, 2000). The use of β -glucan in diets was found to improve growth performance in rabbit (García-Ruiz *et al.*, 2008), swine, poultry (Chae *et al.*, 2006; Huff *et al.*, 2006) and fish (Robertson *et al.*, 1990). It was reported that β -glucan improves the activity of macrophage and heterophils, releases some types of cytokines and raised cellular immunity by adjusting macrophage chemotaxis activity (An *et al.*, 2008).

Rabbits fed diet D3 showed better values ($P<0.05$) for FCR, PI and BWG than control group and insignificantly with D. Fylax forte[®] is composed mainly of organic acids (Sorbic, formic, acetic, lactic, propionic L-ascorbic, and citric acids) and ammonium propionate. It was found that diet supplemented with organic acids improved BWG and FCR of broiler chickens (Abdel fattah *et al.*, 2008, Owens *et al.*, 2008).

The organic acids were thought to inhibit the growth of pathogenic microorganisms like *E. coli*, salmonella and campylobacter spp. and consequently enhance the growth of desirable microflora in the intestine and increase digestive enzyme activity and utilization of essential minerals and amino acids (Ricke, 2003; Dibner, 2004;

Lückstadt, 2005; Gunal *et al.*, 2006 and Owens *et al.*, 2008).

3.3. Diet digestibility:

The apparent digestion coefficients (DC) of OM CP, EE, NDF, ADF, and NFC were significantly higher for the rabbits fed diets D1, D2 and D3 than control diet (Table 4, Figure 2). These results are in agreement with results of Mekkawy *et al.*, (2000), they indicated that inclusion of GBP with enzyme supplementation in rabbit diet improved digestibility of OM and nutrients over the control group. DC of OM and CP were higher significantly ($P<0.05$) in D1 and D3 than rabbits fed diet D2. This may be attributed to that supplementation of organic acids in diet D3 improved protein digestibility by decreasing competition of gut flora with the host rabbit for nutrients and endogenous nitrogen losses with lowering ammonia production and stimulation of gastrointestinal cells proliferation (Dibner and Buttin, 2002). Also, the proliferative effect of organic acids on intestinal villi may improve nutrients absorption by increasing the epithelial cellular mass and surface area (Sakata, 1987). These factors improved microbial protein synthesis that can be used by rabbit's cecotrophia (Bovera *et al.*, 2015). Also the advantage of OM and CP digestibility in D1 (20% GW only) is related to that vitamin C in GW helped improve digestibility of OM and nutrients via its antioxidant property as indicated by Sahin *et al.*, (2002), who found that supplementation of chromium and vitamin C increased digestibility of OM, CP and EE in laying hens. The presence of vitamin C as antioxidants could partially interfere with oxidative protein denaturation and would improve digestibility of nutrients, especially under stress (Seven, 2008).

Figure 1: Body weight change of rabbits fed different diets during the experimental period

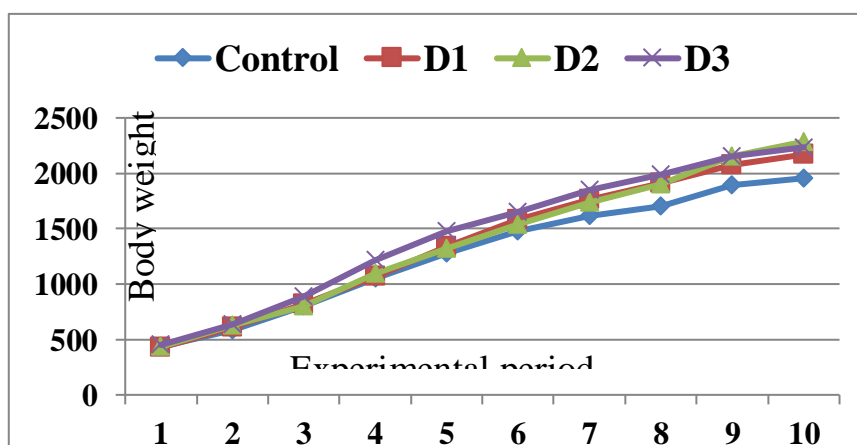
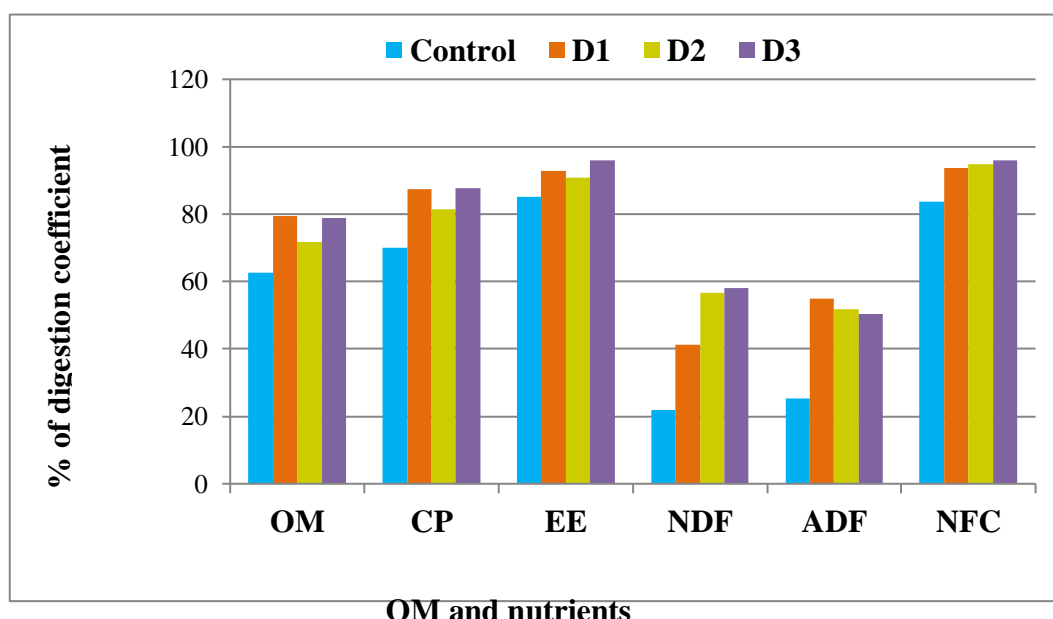


Table 4: Effect of feeding GW (*Psidium guajava* L.) on apparent digestibility of OM and nutrients

	Control	D1	D2	D3	SEM*
OM	62.7 ^c	79.3 ^a	71.8 ^b	78.9 ^a	1.4
CP	69.9 ^c	87.4 ^a	81.4 ^b	87.7 ^a	1.61
EE	85.17 ^c	92.8 ^b	90.7 ^b	95.97 ^a	0.77
NDF	21.9 ^c	41.3 ^b	56.7 ^a	57.95 ^a	4.468
ADF	25.2 ^b	54.8 ^a	51.7 ^a	50.4 ^a	3.62
NFC	83.76 ^c	93.6 ^b	94.9 ^{ab}	95.9 ^a	0.865

*SEM - Standard Error of Mean

^{ab}Within rows means bearing different superscripts differ significantly at P<0.05.**Figure 2: Apparent digestion coefficient of OM and nutrients in rabbits fed different experimental diets.**

In the same trend, DC of NDF and ADF were higher ($P<0.05$) for D1, D2 and D3 than the control diet. With rabbits fed diet D1, DC of NDF and ADF was better than control. This result agrees with that of Mekki et al., (2000) in feeding GBP to growing rabbits. This may attributed to the more digestible CF of GW than that of fennel straw in control diet. For Diet D3, this result is in accordance with that of Gerritsen et al., (2010). The authors found that crude fiber digestibility was improved by supplementation of organic acids to weaned piglets diets.

It is thought that the organic acids exert its effect by balancing microbial population in the intestine and increasing activity the digestive enzymes (Knarreborg et al., 2002). In rabbits fed diet (D3), apparent DC was higher than that of control group. MOS improve gut digestion and absorption via increasing the number of beneficial microbes (Falcão-e-Cunha et al., 2007).

3.4. Carcass traits and blood picture:

Results of carcass traits of growing rabbits (Table 5) showed no significant differences ($P<0.05$) between the experimental groups in most measured percentages of organs and hot carcass. These results agree with the findings of researchers (Falcão-e-Cunha et al. (2007) and Dorra et al., (2013) who indicated that no adverse effect of using MOS or organic acids in the diet of growing rabbits on carcass traits. Also for GW, there was no detectable negative effect on carcass dressing. These findings agree with results of (Mekki et al., (2000). Increased weight of stomach and intestine in rabbits fed diet included Y-MOS[®] and Fylax forte[®] was observed in this study (Table 5). This may be explained as MOS strengthens the luminal muscles due to increased enteric motility (Bovera et al., 2015).

Table 5: Some carcass traits of experimental growing rabbits at 98 d of age

Item	C	D1	D2	D3	SEM*
Weight (g)					
Weight at slaughter	1965.8 ^b	2168.7 ^a	2285.4 ^a	2235 ^a	32.6
Hot carcass (HC)	1109.6 ^b	1224.25 ^a	1287.9 ^a	1239 ^a	20.66
% of weight at slaughter					
Hot carcass	56.5	56.4	56.2	55.5	0.39
Stomach & intestine	14.1 ^a	15.1 ^{ab}	15.1 ^{ab}	16.2 ^b	0.43
Skin	17.3 ^a	16.9 ^{ab}	16.4 ^b	16.3 ^{ab}	0.19
% of HC					
Head	9.57	9.63	9.47	10.18	0.16
Liver	4.97	4.82	4.86	4.75	0.11
Kidneys	1.3	1.28	1.2	1.46	0.052
Lungs	0.89 ^{ab}	0.88 ^b	1.0 ^{ab}	1.07 ^a	0.038
Heart	0.29	0.28	0.28	0.33	0.087

*SEM - Standard Error of Mean ^{ab}Within rows means bearing different superscripts differ significantly at $P < 0.05$.

Table (6): Effect of using GW as feed ingredient in growing rabbit diets on the economic efficiency parameters.

Items(L.E/rabbit)	Control	D1	D2	D3	SEM
Equipment depreciation	2.35	2.35	2.35	2.35	-
Building rent value	3.92	3.92	3.92	3.92	-
Drug cost	1.92	1.92	1.92	1.92	-
Disinfectant cost	0.06	0.06	0.06	0.06	-
Water& Electricity	0.70	0.70	0.70	0.70	-
Labor	5.88	5.88	5.88	5.88	-
Miscellaneous cost	1.00	1.00	1.00	1.00	-
Total Fixed Cost (TFC)	15.83	15.83	15.83	15.83	-
Cost of one ton	3178.04	2993.0	3039.1	3021.1	-
Total feed cost	22.16 ^a ±0.63	18.97 ^c ±0.62	18.61 ^c ±0.84	19.56 ^b ±0.16	0.39
Purchased rabbit	11.34 ^a ±0.78	10.94 ^b ±0.80	11.09 ^a ±1.04	11.26 ^a ±0.17	0.36
Total Variable Cost(TVC)	33.50 ^a ±1.24	29.91 ^b ±1.31	29.70 ^b ±1.80	30.82 ^b ±0.12	0.40
Total Cost(TC)	49.33 ^a ±1.24	45.74 ^b ±1.31	45.53 ^b ±1.80	46.65 ^b ±0.12	0.46
Rabbit sales	60.27 ^b ±2.38	66.56 ^a ±2.45	67.07 ^a ±3.67	66.24 ^a ±1.2	0.96
Litter sales	1.00	1.00	1.00	1.00	-
Total Return(TR)	61.27 ^b ±2.38	67.56 ^a ±2.45	68.07 ^a ±3.67	67.24 ^a ±1.2	0.86
Net Profit(NP)	11.94 ^c ±1.9	21.82 ^a ±1.86	22.54 ^a ±2.54	20.59 ^b ±1.19	0.80
TR/TC	124.20 ^c ±3.79	147.70 ^a ±4.45	149.50 ^a ±5.01	144.13 ^b ±2.61	2.31
NP/TC	24.20 ^c ±3.79	47.70 ^a ±4.45	49.50 ^a ±5.01	44.13 ^b ±2.61	1.79
NP/TR	19.48 ^c ±2.23	32.29 ^a ±1.86	33.11 ^a ±2.27	30.62 ^b ±1.27	0.93

L.E: Egyptian Pound. *Price of kg rabbit sale = 30 L.E.

The mean values with different superscript letter within the same row differ significantly at ($P < 0.05$).

SEM - Standard Error of Mean

The effect of organic acids on enteric weight may be attributed to the stimulation of gastrointestinal cell proliferation and increasing the epithelial cellular mass (Romero et al., 2011). Concerning hematological parameters and chemistry, results were in the normal range for all experimental groups and indicated the proper health of rabbits during the period of experiment.

3.5. Economic efficiency:

Economically, the effects of feeding diet contained GW for different experimental groups (Table 6) showed that the TFC of production had no significant differences ($P < 0.05$) among all experimental groups. Each individual rabbit

received the same costs including labor, veterinary supervision, housing, water and electricity and miscellaneous cost.

Hence, all of these parameters were considered fixed costs according to (Ani and Ugwuowo, 2011). For TVC, the highest value was observed for control group (L.E. 33.50), and the lowest value was for D2 group (L.E. 29.70/rabbit). Regarding total feed cost, control group showed the greatest (L.E 22.16/rabbit) followed by D3 (L.E 19.56) and D1 (L.E 18.97), while the lowest value was for D2 (L.E 18.61). TC value was higher for the control group (L.E 49.33/rabbit) than D1, D2 and D3 (L.E 45.74, L.E 45.53 and L.E 46.65 /rabbit, respectively). So,

results of TVC and TC indicate that including GW (20% of the diet) reduced the production cost.

The cost of one ton of feed was found to be lower for D1, D2 and D3 groups than that of control one. The feed cost/ ton of feed saved about (L.E. 185.04, 138.94 and 156.94 / ton) for D1, D2 and D3, respectively; meanwhile, the control diet has the highest cost/ ton. Meaning that feeding rabbits with diet contained GW reduces feed cost. Concerning TR values obtained from rabbit sales and litter price (Table 6), it were L.E. 68.07/rabbit for D2, followed by L.E. 67.56/ rabbit for D1, L.E 67.24/ rabbit for D3, and finally L.E. 61.27/ rabbit for the control group. NP was significantly higher ($P < 0.05$) for D2, D1 and D3 groups (L.E 22.54, 21.82 and 20.59 / rabbit, respectively), than that for the control group which was L.E. 11.94 / rabbit.

Regarding the economic efficiency measurements among the different experimental groups, the percentages of TR/TC, NP/TC and NP/TR were higher significantly ($p < 0.05$) for D2 and D1 than control and D3 experimental groups. These results indicated that inclusion of GW in rabbit diet either alone or with MOS supplementation was the most profitable when compared with other diets, that agreed with those of (El-Deek et al., 2009; Lira et al., 2009 ; Ani and Ugwuowo, 2011; EL-Manylawi, 2011; El-Sheikh et al., 2013; Gaber et al., 2014 and El-Anany, 2015), they indicated that the use of alternative feed ingredients reduce the overall cost of production with improving profitability. GW can be used effectively as feed ingredient in the diet of growing rabbits at levels of up to 20% without negative effect on the productive and economic efficiency.

ACKNOWLEDGMENT:

The authors are grateful to the Faculty of Veterinary Medicine, Benha University (www.bu.edu.eg).

4. REFERENCES:

- A.O. A. C. 1995. Official methods of analysis of the Association of Official Analytical Chemists, 16th edition.
- Abdel-Fattah, S.A., El-Sanhoury, M.H., El-Mednay N.M., Abdel-Azeem, F. 2008. Thyroid Activity, Some Blood Constituents, Organs Morphology and Performance of Broiler Chicks Fed Supplemental Organic Acids International J. Poult. Sci. 7 (3): 215-222.
- Alvarez, J.L., Marguenda, I., García-Rebollar, P., Carabaño, R., De Blas, C., Corujo, A., García-Ruiz, A.I. 2007. Effects of type and level of fibre on digestive physiology and performance in reproducing and growing rabbits. World Rabbit Sci. 15: 9 – 17.
- Aly, A.M., 1981. Studies on the unsaponifiable matter of some vegetable oils. M.Sc. Thesis, Faculty of Agriculture, Minufiya University, Egypt.
- An, B. K., B. L. Cho, S. J. You, H. D. Paik, H. I. Chang, S. W. Kim, C. W. Yun1 and C. W. Kang. 2008. Growth Performance and Antibody Response of Broiler Chicks Fed Yeast Derived β -Glucan and Single-strain Probiotics. Asian-Aust. J. Anim. Sci. 21(7) 1027 – 1032.
- Ani, A. O. and Ugwuowo, L. C. 2011. Response of weaner rabbits to diets containing graded levels of processed velvet beans (*Mucuna pruriens*). African Journal of Biotechnology 10, 14984-14989.
- Association of Official Analytical Chemists, Washington DC, USA.
- Atallah, S.T. 1997. Economic and productive efficiency of veterinary management in dairy farms. Ph.D. Thesis, Fac. Vet. Med., Alex. Univ., Egypt.
- Atallah, S. T. 2004. Effect of cattle diseases on reproductive, productive and economic efficiency of dairy farms. Minufiya Vet. J. 1, 99.
- Belifield and Goldberg .1971. Ann. Biol. Clin. 44:686.
- Bernardino Nicanor, a., Ort, i. A. Z. O. I., mart, a. L. N. Y. , Davila, G. O. 2000. Guava seed protein isolate. functional and nutritional characterization. Journal of food biochemistry 25, 77-90.
- Bikrisima, S. H. L., Mahfudz, L. D., Suthama, N. 2014. Production Capacity of Broiler Chickens Fed Red Guava Fruit Meal as Source of Natural Antioxidant. <http://repository.unhas.ac.id/handle/123456789/12617>.
- Blasco, A., Ouhayoun, J. 1993. Harmonization of criteria and terminology in rabbit meat research: Revised proposal. World Rabbit Science 4, 93-99.
- Bovera, F., A. Lestingi, F. Iannaccone, A. Tateo, and A. Nizza. 2015. Use of dietary mannanoligosaccharides during rabbit fattening period: Effects on growth performance, feed nutrient digestibility, carcass traits, and meat quality. J. Anim. Sci. 2012.90:3858–3866.
- Calsamiglia, S., Stem, M.D. & Frinkins, J.L. 1995. Effects of protein source on nitrogen metabolism in continuous culture and intestinal digestion in vitro. J. Anim. Sci., 73:1819.
- Carabaño R., Motta-Ferreira, W., De Blas, C., Fraga, M.J. 1997. Substitution of sugar beet pulp

- for alfalfa hay in diets for growing rabbits. *Anim. Feed Sci. Technol.* 65, 249-256.
- Chae, B.J., Lohakare, J.D., Moon, W.K., Lee, S.L., Park, Y.H., Hahn, T.W. 2006. Effects of supplementation of β -glucans on the growth performance and immunity in broilers. *Research in Veterinary Science*, 80(3), 291-298.
- Cheeke, P.R. 1987. Rabbit feeding and nutrition. Academic Press. Orlando, Florida, U.S.A.
- Crampton, E.W. and Harris, L.A. 1969. Applied Animal Nutrition. 2nd Edition. San Fransisco, USA, G.w. Freeman and co.
- Daszkiewicz T., Gugolek A., Janiszewski P., Kubiak D., Czoik M. 2012. The Effect of Intensive and Extensive Production Systems on Carcass Quality in New Zealand White Rabbits. *World Rabbit Sci.* 20: 25 – 32.
- De Blas, C., Weiseman, J. 2010. Nutrition of the Rabbit, 2nd Edition. Printed and bound in the UK by CPI Antony Rowe Ltd, p.84.
- De Blas C., García J., Gomez-Conde S., Carabaño R. 2002. Restricciones a la formulación de piensos para minimizar la patología digestiva en conejos. In: Proc. XVIII Symposium FEDNA, Barcelona, Spain, 157-163.
- Denny, C., Priscilla, S. M., Franchin, M., Massarioli, A. P., Bergamaschi, K. B. 2013. Guava pomace: a new source of anti-inflammatory and analgesic bioactives. *Complementary and Alternative Medicine.* 13. 235.
- Dibner, J. 2004. Organic acids: Can they replace antibiotic growth promoters? *Feed Int.* 25: 14-16.
- Dibner, J. J. and Buttin, P. 2002. Use of organic acids as a model to study the impact of gut microflora on nutrition and metabolism. *J. Appl. Poult. Res.* Vol. 11:453-46
- Dorra, T. M. I.; F. S. A. Ismail; Kh. El. Sherif and Marwa M. H. Rabie. 2013. Growth performance of fattening rabbits as affected by stocking density and added dietary organic acids. *J. Animal and Poultry Prod., Mansoura Univ., Vol.4 (5): 249 - 262.*
- Duncan, D. B. 1955. Multiple range and multiple F tests. *Biometrics.* 11, 1-42.
- El-Deek A. A., M. A. Asar, S. M. Hamdy, and A. A. Abdalla. 2009a. Utilization of guava by-products in broiler finisher diets. *Egypt. Poult. Sci.* 29, 53-75.
- El-Deek A.A., Safa M. Hamdy, Y.A. Attia and A.M. El-Shahat. 2009b. Guava By-Product Meal Processed in Various Ways and Fed in Differing Amounts as a Component in Laying Hen Diets. *International J. Poult. Sci.* 8 (9): 866-874.
- EL-Manylawi, M. A. F. 2011. Response of growing New Zealand white rabbit to dietary date stone meal with or without commercial enzyme supplementation. First International Scientific Conference for the Development of Date Palm and Dates sector in the Arab World., 899-908.
- Falcão-e-Cunha L., Castro-Solla L., Maertens L., Marounek M., Pinheiro V., Freire J., Mourão J.L. 2007. Alternatives to Antibiotic Growth Promoters in Rabbit Feeding: A Review. *World Rabbit Sci.* 15: 127 – 140.
- Falcao-e-Cunha L., Peres E., Freire J., Castro-Solla L. 2004. Effects of alfalfa, wheat bran or beet pulp, with or without sunflower oil, on caecal fermentation and on digestibility in the rabbit. *Anim. Feed Sci. Technol.* 117, 131-149.
- Fardos, A. Hassan 2009. Effect of Some Feed Additives on Economic and Productive Efficiency of Broilers. Master degree ,faculty of veterinary medicine , Zagazig university Egypt.
- Fekete S., Gippert T. 1986. Digestibility and nutritive value of nineteen important rabbit feedstuffs. *J. Applied Rabbit Res.,* 9: 103-108.
- Feldman, B. F., Zinkl , J. G. and Jain, N. C. 2000. *Schalms Veterinary Haematolog.* 5 Ed. Philadelphia, Williams Tand Wilkins. 21-100.
- García G., Galvez J.F., De Blas C. 1993. Effect of substitution of sugar beet pulp for barley in diets for finishing rabbits on growth performance and on energy and nitrogen efficiency. *J. Anim. Sci.* 71: 1823-1830.
- García-Ruiz A.I., Pérez-Bonilla A. ,Pérez de Ayala P., Eissen J. 2008. EFFECT OF YEAST β -GLUCANS ON RABBIT PERFORMANCES AND MORTALITY FROM 35 TO 63 DAYS OF AGE. <https://world-rabbit-science.com/WRSA-Proceedings/Congress-Verona/Papers/N-Garcia-Ruiz.pdf>.
- Gerritsen R., Dijk A.J., Rethy K., Bikker P. 2010. The effect of blends of organic acids on apparent faecal digestibility in piglets. *Livest. Sci.* 134: 246–248.
- Gunal, M., Yayli, G., Kaya, O., Karahan, N., Sulak, O. 2006. The effects of antibiotic growth promoter, probiotic or organic acid supplementation on performance, intestinal microflora and tissue of broiler. *Int. J. Poult. Sci.* 5: 149-155.
- Gutiérrez, R., Mitchell, S., Solis, R. V. 2008. Psidium guajava. A review of its traditional uses, phytochemistry and pharmacology *Journal of Ethnopharmacology* 1.
- Habib, M.A.1986. Studies on the lipid and protein composition of guava seed (psidiuym guayava).*Food Chem.* 22: 7-16.

- Hassanein, E. I., El – Kohli, M. I., Wafaa, E. and Walaa, A. E. 2002. Basic livestock nutrition. Chapter 8. 230.
- Henry, R.J. 1964. Clinical Chemistry, Principle and Techniques. Haper and Row Publishers. New York.
- Holland, B., A.A. Welch, I.D. Unwin, D.H. Buzz, A.A. Paul and A.T. Southgate. 1991. McCance and Widdowson's, The Composition of Foods. UK: The royal Society of Chemistry and Ministry of Agriculture, Fishers and Food.
- <http://faostat.fao.org>. (data updated 4. August, 2014).
- Huff, G.R., Huff, W.E., Rath, N.C., Tellez, G. 2006. Limited treatment with β -1,3/1,6 glucan improves production values of broiler chickens challenged with *Escherichia coli*. Poultry Science, 84 (4): 613-618.
- Husdan and Rapaport .1968. Estimation of creatinine by the Jaffe reaction. Clinic chemist 14:222-226.
- Kannan, D., Viswanathan, K. , Mohan, B. 2005. Effect of feeding antibiotic and probiotic on the immune status and carcass characteristics of broiler. Indian J. Poult Sci. 40, 93-95.
- Khalifa, I. A. E. 2014. Utilization of Some Agriculture Residues in Food Processing. M.Sc.Thesis, Faculty of Agriculture, Benha University.
- Knarreborg, A., Miquel, N., Granli, T., Jensen, B.B. 2002. Establishment and application of an in vitro methodology to study the effects of organic acids on coliform and lactic acid bacteria in the proximal part of the gastrointestinal tract of piglets, Anim. Feed Sci. Technol. 99 131–140.
- Labibah, B. A. 2009. Antioxidant activity of the peels of guava, papaya and pine apple. Final year project submitted in partial fulfillment of the requirements for the degree of Bachelor of Science (Chemistry) in the Faculty of Applied Sciences Universiti Teknologi MARA.
- Lira, R.C., C.B.V. Rabello, E.P. da Silva, P.V. Ferreira, M.C.M.M. Ludke, E.V. Costa. 2011. Chemical composition and energy value of guava and tomato wastes for broilers chickens at different ages. Revista Brasileira de Zootecnia, v.40, n.5, p.1019-1024.
- Lira, R. C., Rabello, C. B.-V.; Ferreira, P. V., Lana, G. R. Q.; Lüdke, J. V. and Dutra Junior, W. M. 2009. Inclusion of guava wastes in feed for broiler chickens. Revista Brasileira de Zootecnia 38: 2401-2407.
- Lückstädt, C. 2005. Acid-phytobiotic blends. A sustainable alternative for feed safety, animal health and natural growth promotion in pig farming. Feed Mix, 13 (4), 25-27.
- Marquina, V., L. Araujo, J. Ruíz, A. Rodríguez-Malaver and P. Vit, 2008. Composition and antioxidant capacity of the guava (*Psidium guajava* L.) fruit, pulp and jam]. Archive Latinoam Nutr., 58: 98-102.
- Mathew, T. J., M. M. Ndamitso , A. A. Otori , E. Y. Shaba , A. Inobeme , A. Adamu. 2014. Proximate and Mineral Compositions of Seeds of Some Conventional and Non Conventional Fruits in Niger State, Nigeria. Academic Research International Vol. 5(2) March.
- Mekkawy, S.H., El-Faramawy, A.A., Zakaria, S. M. 2000. Influence of Guava by-Product, Enzyme Supplementation and Gamma Irradiation on Performance and Digestive Utilization of Fattening Rabbits. Egyptian Journal of Radiation Sciences and Applications; ISSN 1110-0303; v. 13(1):139-149.
- Mohamed, A. E. O. 2014. Economic Evaluation of Probiotic (*Lactobacillus acidophilus*) Using in Different broiler Breeds within Egypt. Banha veterinary medical journal, 4.
- Mohamed, A.A., K. El-Shazly and A.R. Abou Akkada, 1971. The use of some agriculture by-products in feeding of farm animals. Alexandria J. Agri. Res., 19: 25-32.
- Mourão, J.L. , V. Pinheiro, A. Alves, C.M. Guedesa, L. Pinto, M.J. Saavedra, P. Spring, A. Kocher. 2006. Effect of mannan oligosaccharides on the performance, intestinal morphology and cecal fermentation of fattening rabbits. Animal Feed Science and Technology. Volume 126, Issues 1–2: 107–120.
- National Research Council (NRC) 1977. Nutrient requirements of domestic animals. Nutrient Requirement of Rabbits, 2nd revised edition. USA National Academy of Science. Washington, D.C.
- North, M. O. 1981. Commercial Chicken. Production Annual. 2nd Edition, Production 6th Ed. Interstate Printers and Publishers. INC., USA.
- Opute, E.I., 1978. The component fatty acids of *psidiuym guayava* seedless. J. Sci. Food Agric., 29: 737.
- Owens, B., Tucker, L., Collins, M. A. and McCracken, K. J. 2008. “Effects of different feed additives alone or in combination on broiler performance, gut micro flora and ileal histology,” British Poultry Science, vol. 49, no. 2: 202–212.
- Perez, J.M., Lebas, F., Gidenne, T., Maertens, L., Xiccato, G., Parigi-Bini, R., Dalle Zotte, A., Cossu, M.E., Carazzolo, A., Villamide, M.J., Carabano, R., Fraga, M.J., Ramos, M.A., Cervera,

- C., Blas, E., Fernandez, J., Falcao e Cunha L., Bengala Freire, J. 1995. European reference method for in vivo determination of diet digestibility in rabbits. *World Rabbit Sci.*, 3: 41-43.
- Prasad, N. B. L. and Azeemoddin, G. 1994. characteristics and composition of guava (*Psidium peruvianum* L.) seed and oil. *J. Soil Chern Soc.* 72: 457- 458.
- Ricke, S.C. 2003. Perspective on the use of organic acids and short chain fatty acids as antimicrobials. *Poult. Sci.* 82: 632-639.
- Robertsen, B., Rorstad, G., Engstad, R., Raa, J. 1990. Enhancement of non-specific disease resistance in Atlantic salmon, *Salmo salar* L., by a glucan from *Saccharomyces cerevisiae* cell walls. *J. Fish Disease*, 13: 391- 400.
- Romero, C., Rebollar, P.G., Dal Bosco, A., Castellini, C., Cardinali, R. 2011. Dietary Effect of Short-chain Organic Acids on Growth Performance and Development of Intestinal Lymphoid Tissues in Fattening Restricted Rabbits. *World Rabbit Sci.*, 19: 133 – 142.
- Sahin, K., Nurhan Sahin, Osman Kucuk. 2002. Effects of dietary chromium and ascorbic acid supplementation on digestion of nutrients, serum antioxidant status, and mineral concentrations in laying hens reared at a low ambient temperature. *Biological Trace Element Research*, Volume 87, Issue 1: 113-124.
- Sakata, T. 1987. Stimulatory effect of short-chain fatty acids on epithelial cell proliferation in the rat intestine: a possible explanation for trophic effects of fermentable fibre, gut microbes and luminal trophic factors. *Brit. J. Nutr.*, 58: 95-103. doi:10.1079/BJN19870073.
- Sanda, K. A.; Grema, H. A.; Geidam, M. A. and Bukar-Kolo, Y. M. 2011. Pharmacological aspects of *Psidium guajava*. *International Journal of Pharmacology*. 7, 316-324.
- Sankhyan, L. P. 1983. Introduction to farm management. Tata MC-Grow Hill Publishing Company Limited New Delhi.
- Santos, E.L., Ludke, M.C.M.M.; Barbosa, J.M. 2009. Digestibilidade aparente do farelo de coco e do resíduo de goiaba para tilápia do Nilo. *Caatinga*, v.22, n.2:175-180.
- Seven P.T., 2008. The Effects of Dietary Turkish Propolis and Vitamin C on Performance, Digestibility, Egg Production and Egg Quality in Laying Hens under Different Environmental Temperatures. *Asian-Aust. J. Anim. Sci.* Vol. 21, No. 8 : 1164 – 1170.
- Shreya, V., Amarapurkar, C., Murthy, B. and Naik, K. 2014. Costs and returns in commercial broiler rearing in Dharwad district. *International Journal of Commerce and Business Management* 7: 316-319.
- Silva, J.D.A. 1999. Composição química e digestibilidade in situ da semente de goiaba (*Psidium guajava* L.). 34f. Dissertação (Mestrado em Produção Animal) – Universidade Federal Rural de Pernambuco, Recife.
- Spring P, Wenk C, Dawson KA and Newman KE. 2000. Effect of mannan oligosaccharide on different cecal parameters and on cecal concentration of enteric bacteria in challenged broiler chickens. *J. Poult. Sci.* 79: 205-11.
- Tokunaka, K., Ohno, N., Adachi, Y, Tanaka, S., Tamura, H., Yadomae, T. 2000. Immunopharmacological and immunotoxicological activities of a water-soluble (1→3)-beta-D-glucan, CSBG from *Candida* spp. *Int J Immunopharmacol* 22:383-94).
- Uchôa-Thomaz, A. M. A., E. C. Sousa, J. O. B. Carioca, S. M. de Moraes, A. de Lima, C. G. Martins, C. D. Alexandrino, P. A. T. Ferreira, A. L. M. Rodrigues, S. P. Rodrigues, J. C. A. Thomaz, J. N. Silva, L. L. Rodrigues. 2014. Chemical composition, fatty acid profile and bioactive compounds of guava seeds (*Psidium guajava* L.). *Food Sci. Technol*, Campinas, 34(3): 485-492.
- Uddin, M.S., M.N.A. Hawlader, Luo Ding and A.S. Mujumdar, 2002. Degradation of ascorbic acid in dried guava during storage. *J. Food Eng.*, 51: 21-26.
- VAN SOEST, P. J. – ROBERTSON, J. B. – LEWIS, B. A. 1991. Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. *J. Dairy Sci.*, 1991, vol. 74: 3583-3597.