The Effect of Adding Different Levels of Wheat Germ Oil without or with Folic Acid to Rabbit's Diet in Improving Growth and Digestion

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Abstract

The present study aimed to investigate the effect of wheat germ oil (WGO) with or without folic acid on rabbit body weight, growth rate, feed consumption, feed efficiency and nutrient digestion at different ages. This experiment was conducted in one of the breeding halls of the Department of Animal Production at the College of Agriculture/ University of Basrah from 1-2-2018 to 1-7-2018 preceded by an introductory period of 10 days for the acclimatization of animals. Eight males and 56 female rabbits were purchased from local markets, at the age of two months, with an average weight of (650, 810) grams for males and females, respectively. The animals were divided randomly into four groups (14 females + 2 males/ group) The first group is a control group (no WGO) and the 2nd, 3rd, and 4th groups were given WGO orally at a dose of 0.25, 0.50 and 0.75 ml/ kg body weight/ day respectively for five months. After two months of, treatments the 2nd, 3rd, and 4th group were divided into two groups. The 1st group of each treated group continued received the same dose of WGO according to experimental protocol while the 2nd group of each treatment received the same dose of WGO plus folic acid at a dose of(1 mg/ kg of body weight/ animal) at the age of 150 days (puberty).The results revealed that dosing rabbit with WGO improved body weight at the age of puberty and pregnancy, especially the 0.75 ml/kg dose without folic acid (2887.95, 3087.95 and 3641.45 gm at 150 days of age, 15 and 30 days of pregnancy respectively). Those with folic acid were 2887.95, 3105.90 and 3660.85 gm respectively. Growth rate of 0.75 WGO with folic acid exceeded all other groups at 15 and 30 days of pregnancy (7.27 and 36.99 gm respectively). These improvements are reflecting the better digestion coefficients of drymaters (DM), Curde protein (CP) and curde fiber (CF) of the group dosed with 0.75 WGO with folic acid at 150 days of age (69.96%, 84.96% and 77.25% respectively).

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1. Introduction

There is a growing awareness of the importance of plant oils as a source of food, and consequently, the global demand for crops oils has increased [1]. Wheat germ, or wheat germ pulp, is a food substance that has been included in nutritional products as a nutritional supplement [2].Wheat germ is an important byproduct in flour-making processes and because the wheat germ's oil content is limited, it is therefore usually used commercially to assess the quality of the flour [3].As for wheat germ oil, it has a high content of tocopherol (compared to most other vegetable oils), which amounts is 2500 mg/ kg, and this represents about 60% of the total content [4].In addition to that, wheat germ oil (WGO) has a high content of unsaturated fatty acids, especially linoleic acid and linolenic acid. These two types of fatty acids have great importance in the metabolism process and cannot be produced by the organism [5].WGO works to improve and increase body weight through a rapid increase in the content of members of vitamin E, and this vitamin has a role in increasing the weights of different organs such as the brain, liver, lungs, spleen, heart, kidneys and other tissues, which reflects positively on the overall body weight [6,7]. As well as the wheat germ contains a high percentage of protein. Therefore, consuming this substance on a continuous basis leads to a noticeable increase in the weight of the animals whose wheat germ oil includes [8]. Wheat germ can maintain and stimulate the work of the digestive system, because it is rich in fiber, as the high fiber content makes it a good regulator of bowel movement and its regular work and sometimes it is recommended to use it by patients with colon diseases [9]. Folic acid, also known as vitamin B9, it is one of the necessary complex vitamins in protein and fat metabolism and helps in maintaining the gut, skin, nervous tissue, muscles and other tissues in the body. Folic acid also helps in the production of nucleic acids, which is necessary in periods of rapid growth such as pregnancy.Rabbits are intermediate animals between ruminants and poultry, as their digestive system can digest rough fodder materials, so they are herbivorous, as they are widely raised in some developing countries and their production contributes to improving family nutrition and economy as a source of animal protein [10]. In Iraq, there are some studies about using different sources of oil on some animals such as treatment female rabbit with Conconut oil extract on their wound healing **[11]** or add different levels of Pumpkin seed oil, with or without vitamin E to Japanese Quail`s diets to study it is the effect on productivity and reproductive performance **[12]**, and, compared between two kinds of lipids, fish oil and animal fat on some biochemical parameters of blood rabbits **[13].** The aim of the present study was to investigate the effect of

adding different levels of WGO and folic acid on live weights, daily growth rate, feed conversion efficiency, feed consumption, and the digestion coefficients of dry matter, protein, and crude fiber in rabbits.

2. Material and Methods

This experiment was conducted in one of the breeding halls of the Department of Animal Production at the College of Agriculture/ University of Basra from 1-2-2018 to 1-7-2018 preceded by an introductory period of 10 days for the acclimatization of animals. Eight males and 56 female local breed rabbits were purchased from local markets, at the age of two months, with an average weight of (650 ±50, 810 ± 50) grams for males and females, respectively. The animals were divided randomly into four equal groups (14 females + 2 males/ group) and two replicates/ groups. The treatment groups were dosed with WGO produced by the Pakistani company Hemani orally for a period of five months. The first group is a control group (without wheat germ oil) and the 2nd, 3rd, and 4thgroupswere given WGO at a dose of 0.25, 0.50 and 0.75 ml / kg body weight/ day respectively [14]. After two months of giving WGO, treatments 2, 3 and 4 were divided into the two groups. The 1st group of each treated group continued receiving the same dose of WGO according to experimental protocol, while the 2nd group of each treatment received the same dose of WGO plus folic acid at a dose of (1 mg/ kg of body weight/ animal) at the age of 150 days (puberty) [15]. The animals were fed a basic diet consisting of yellow corn, wheat, soybean meal, fish meal, sunflower oil, limestone and table salt (38.25, 30.00, 13.00, 10.00, 1.00, 7.50, and 0.25% respectively).Feed was given as 2% of body weight at seven o`clock in the morning at every day with the introduction of available green fodder such as herb, grass and Turnip plant (it was weighed before serving) as well as the availability of free water throughout the study period with plastic strips. The amount of feed provided was adjusted based on the new weight of each group every two weeks. The animals were weighed at the beginning of the experiment, the initial weights were recorded, and then they were weighed every two weeks from the beginning of the experiment to the end to estimate the achieved weight gain. In addition, the amount of remaining feed in the next day was calculated, in order to estimate the amount of feed consumption and feed conversion ratio (kg feed consumption/ kg growth rate) at the age of 150 days of the experiment. The amount of litter produced (at the age of 150 days) from all groups was calculated daily for a period of three days after mixing, drying and grinding, three samples (10 gm each) from each group to estimate the coefficient of digestion of dry

matter, crude protein and crude fiber [16]. Chemical analysis of both feed and litter was according to [17]. Data were statistically analyzed by completely randomized design (CRD) of four treatments. Differences among treatments were tested by the revised least significant differences test (RLSD) within [18] program.

3. Results and Discussion

3.1 Body weight

The results shown in Table 1 represent the effect of WGO and folic acid on animal weight. Weight at 90 days of age showed no significant differences among all studied groups. However, from the age of 120 days and on, the addition of 0.75 ml/kg WGO with or without folic acid enhanced ($P<0.05$) body weight in comparison with control and the group received 0.25 ml/kg WGO. A significant increase ($P <0.05$) in the body weights was observed in the animal group dosed with WGO at a dose of 0.75ml/kg BW and animal group dosed with WGO (0.75 + 1mg folic acid), at sexual puberty, 15 and 30 days of pregnancy (2887.95, 3087.95, 3641.45 and 2887.95, 3105.90, 3660.85 gm) respectively compared with control and other treated groups. The fact that WGO contains vitamin E led to an increase in its content in various parts of the body, which may contribute to the body's weight gain due to its role in inhibiting free radicals as it is an important anti-oxidant component [6,7].Wheat germ oil contains a good percentage of essential fatty acids such as linoleic and oleic acids that improve metabolism and reduce cholesterol levels and endure continuous stress on muscles, which enhances the production and formation of new cells [19].As for the reason for the increase in live weights in the pregnancy stage of animals treated with wheat germ oil, it may be attributed to the fact that vitamin E supplementation and essential fatty acids (the omega group) have a role in the fetus's growth, as a positive relationship has been found between the concentration of tocopherol in the blood of mothers and the development of the fetus and this is consistent with the findings of [20].

Table 1: Live body weights of rabbits dosed with WGO and folic acid at different (physiological status) (Mean± standard deviation)

Treatments	Mean of body weight (gm)					
	Initial (60	90 days	120 days	150 days (Puberty)	15 days of pregnancy	30 days of pregnancy

		day)					
Control		650.00 ± 44.00	1116.67 ± 63.10	1852.86b ± 96.70	2752.00b ± 96.89	2886.86b ± 112.30	3309.18c ± 109.90
T1	WGO 0.25 ml/kg	650.25 ± 39.00	1130.20 ± 53.60	1889.25ab ± 52.50	2829.15ab ± 58.80	2987.15b ± 67.10	3523.40bc ± 115.60
	WGO 0.25 ml/kg + 1 mg/kg folic acid				2829.15ab ± 58.80	2999.15b ± 103.40	3537.50bc ± 101.50
T2	WGO 0.50 ml/kg	650.46 ± 32.00	1137.96 ± 35.90	1917.96ab ± 40.60	2870.46ab ± 68.40	3058.46ab ± 37.40	3598.45b ± 113.70
	WGO 0.50 ml/kg + 1 mg/kg folic acid				2870.46b ± 68.40	3070.45b ± 69.10	3623.65b ± 94.60
T3	WGO 0.75 ml/kg	650.25 ± 39.00	1146.75 ± 52.80	1931.55a ± 44.50	2887.95a ± 71.10	3087.95a ± 98.00	3641.45a ± 95.90
	WGO 0.75 ml/kg + 1 mg/kg folic acid				2887.95a ± 71.10	3105.90a ± 94.10	3660.85a ± 115.81

The different letters in each column indicate a significant difference between ($P \leq 0.05$) groups in each period

3.2 Daily body weight gain

Table 2 shows the effect of WGO and folic acid on the body weight gain of experimental animals. It was found that no significant differences were observed in the weight gain between all treated groups compared with the control group in the 90 and 150 days of treatment. As for

the period of pregnancy, a significant difference (P<0.05) was observed in the group of animals that were dosed with WGO at a concentration of 0.50 ml/ kg with or without folic acid at 15 days of pregnancy (13.33 and 12.53 gm respectively) and at 30 days of pregnancy (36.95 and 35.90 gm respectively). The same significant differences were shown by the group of rabbit dosed with 0.75 ml/kg with or without folic acid in comparison with the control group. It is clear from the above results that adding WGO with or without folic acid, especially 0.75 mg / kg, has improved the daily weight gain of rabbits in different periods of age. The reasons behind that WGO contains elements with the high biotic activity which vitamin E comes in front, as WGO contains about 255 Mg/ 100 gm, i.e. feeding 1 g of WGO/ day provides 135% of the requirements of vitamin E and 35% of the daily requirements for omega 3. These substances also have an important role in getting rid of free radicals and building various body tissues, especially body fat and improving organ performance important in metabolism such as the liver [**21**, **22**].

Table 2: daily weight gain for rabbits dosed with WGO and folic acid at different physiological status (Mean± standard deviation)

Treatments		Daily weight gain (gm)				
		90 days	120 days	150 days (Puberty)	15 days of pregnancy	30 days of pregnancy
Control		15.50 ± 3.30	24.54 ± 3.60	29.97c ± 3.90	8.99c ± 0.50	28.15b ± 4.90
T1	WGO 0.25 ml/kg	16.00 ± 3.10	25.30 ± 3.60	31.33bc ± 0.51	10.53bc ± 0.51	35.75a ± 4.60
	WGO 0.25 ml/kg + 1 mg/kg folic acid				11.33b ± 0.54	35.89a ± 4.50
T2	WGO 0.50 ml/kg	16.25 ± 3.00	26.00 ± 3.90	31.75b ± 0.54	12.53b ± 0.54	35.90b ± 4.70
	WGO 0.50 ml/kg + 1 mg/kg folic acid				13.33a ± 0.51	36.95a ± 4.60
T3	WGO 0.75 ml/kg	16.55 ± 3.33	26.16 ± 3.80	31.88ab ± 0.60	13.33a ± 0.60	36.90a ± 5.90
	WGO 0.75				14.53a	36.99a

	ml/kg + 1 mg/kg folic acid		± 0.61	± 5.81

The different letters in each column indicate a significant difference between (P≤0.05) groups in each period

3.3 Daily feed intake

Table 3 shows the average daily feed intake of rabbits in the control group and groups that dosed with wheat germ oil without or with folic acid at different ages. As a result of group feeding, the statistical analysis could not find the differences among different treatments. The average amount consumed by the control group at the age of 90 days and 30 days after pregnancy was 70.00 and 195.00 g/ d respectively. Whereas when adding wheat germ oil (75% ml / kg) with folic acid, it reached 73.65 and 177.75 g/ day, respectively. These ranges were similar to those found by [23,24].

Table 3: daily feed intake of rabbits treated with WGO and folic acid at different physiological status (Mean± standard deviation**)**

Treatments		Mean of feed intake (gm)				
		90 days	120 days	150 days (Puberty)	15 days of pregnancy	30 days of pregnancy
Control		70.00	120.00	120.99	189.75	195.00
T1	WGO 0.25 ml/kg	72.16	121.44	128.45	189.14	189.47
	WGO 0.25 ml/kg + 1 mg/kg folic acid			128.45	191.10	190.22
T2	WGO 0.50 ml/kg	72.96	116.48	127.00	188.89	188.10
	WGO 0.50 ml/kg + 1 mg/kg folic acid			127.00	190.88	188.10
T3	WGO 0.75 ml/kg	73.65	115.36	124.33	172.00	177.12
	WGO 0.75 ml/kg + 1 mg/kg folic acid			124.33	174.60	177.75

3.4 Feed conversion ratio

The efficiency of feed conversion ratio (table, 4) was not significantly affected when rabbits received WGO at different levels with or without folic acid since the experiment started at the age of (60 days) until the age of sexual puberty (150 days). While it was affected significantly (P<0.05) after pregnancy by (15 and 30 days) (Table 4). Significant (P <0.05) improved in feed conversion ratio when wheat germ oil dosed by 0.25-0.75 ml/ kg compared to the control group for the two periods. The group that received 0.75 ml/ kg of WGO without or with folic acid scored the best feed conversion efficiency and reached 4.8 gm feed/ gm weight gain at the age of 30 days of pregnancy.

Table 4: feed conversion ratio of WGO and folic acid treatments at different physiological stages (Mean± standard deviation)

Treatments		Mean of feed conversion ratio (gm feed/gm body weight)			
		90 days	120 days	150 days (Puberty)	After 30 days of pregnancy
Control		4.50 ± 0.30	4.89 ± 0.60	4.00 ± 0.90	6.93c ± 0.90
T1	WGO 0.25 ml/kg	4.51 ± 0.45	4.80 ± 0.76	4.10 ± 0.59	5.29b ± 0.65
	WGO 0.25 ml/kg + 1 mg/kg folic acid			4.10 ± 0.59	5.30b ± 0.76
T2	WGO 0.50 ml/kg	4.49 ± 0.41	4.48 ± 0.90	4.00 ± 0.66	5.10b ± 0.70
	WGO 0.50 ml/kg + 1 mg/kg folic acid			4.00 ± 0.66	5.10b ± 0.60
T3	WGO 0.75 ml/kg	4.45 ± 0.43	4.41 ± 0.80	3.89 ± 0.59	4.80a ± 0.90
	WGO 0.75 ml/kg + 1 mg/kg folic acid			3.89 ± 0.59	4.80a ± 0.81

The different letters in each column indicate a significant difference between (P≤0.05) groups in each period. When comparing mean of feed conversion efficiency for all treatments, it was

similar to that found by [25] and [23] who scored feed conversion efficiency averages 3.0 and 3.5 gm feed/ g weight gain, respectively. The results shows an increase in the amount of feed intake with age, with a decrease in the rates of weight gain, especially after sexual puberty until 15 days of pregnancy, in which the growth of the does has stopped almost with a very slight increase in weight that may be due to the growth of fetuses, fetal membranes and fluids, which was negatively reflected feed efficiency, expressed in nutritional conversion coefficient, which recorded unnormal figures, with almost the amount of feed intake of 200 gm/ day/ head with increased slightly by weight 4-7 gm/ day.

3.5 Digestion rate

The addition of wheat germ oil resulted in a significant improvement (P≤0.05) in the parameters of digestion of dry matter, protein and fiber at the age of 150 days (Table 5).Rabbits dosed by 0.50 and 0.75 mg/kg WGO showed better dry matter digestion rates (67.44 and 69.96%, respectively), and protein digestion rate (83.36 and 84.96%, respectively), and crude fiber (74.93 and 77.25%, respectively), compared to those of control group (64.25, 80.02 and 71.76% for dry matter, protein and fiber, respectively).

Table 5: Digestibility coefficients for dry matter, protein and crude fiber of rabbits fed wheat germ oil at the age of 150 days (Mean± standard deviation)

Treatments	Mean of Digestion Coefficient (%)		
	Dry Matter	Crude Protein	Crude Fiber
Control	64.25±0.94 c	80.02±1.15 b	71.76±0.91 c
T1 (0.25 mg WGO/kg)	65.94±1.01 b	82.69±1.69 ab	73.18±1.02 bc
T2 (0.50 mg WGO/kg)	67.44±0.65 b	83.36±1.30 a	74.93±1.11 b
T3 (0.75 mg WGO/kg)	69.96±0.95 a	84.96±1.35 a	77.25±1.36 a

The different letters in each column indicate a significant difference between (P≤0.05) groups in each period.From observing these values, their rates are within the normal limits for rabbits at sexual maturity, especially since advancing age leads to the development of the gut and the growth of microorganisms in the cecum, which reflects positively on the nutrients digestion rate of the diet [26].The rates of digestion also depend on the chemical composition of feeds. Concentrated feeds provide both protein and energy in an accessible manner, which leads to the ease of digestion and absorption of nutrients, especially in monogastric animals [27].Fibers are the main influencing factor in the digestion process, because they accelerate the passage of fodder in the gut and may significantly reduce the digestion the organic matter and the feed net

energy [28]. As for the coefficient of protein digestion, it depends on the content of crude protein in the feed material and has a positive correlation with it as the ratio of nitrogen in the feces increases when the protein level in the diet decreases. Also, the high level of protein in the diet helps the digestion of crude fibers due to the availability of the nitrogen component needed by microorganisms in the cecum that degraded and digest the fodder [**26**].On the other hand, the type of protein in the diet affects the protein digestibility, the rate of microorganisms' growth in the gut and the rate of nitrogen fermentation in the cecum, which all affect the rate of digestion of the dry matter [**27**].The digestibility factors obtained in this study are similar to those obtained by [**29**] when rabbits fed balanced protein and energy diets.

4. Conclusions

Giving rabbits a dose of WGO by 0.75 ml/ kg body weight/ day improve body weight at sexual puberty. Adding folic acid by 1 mg/ kg of body weight/ animal for the same dose of oil during pregnancy leads to an improvement in weights compared to the control group. Doses of 0.50 and 0.75 ml of oil/ kg of body weight improve the digestion of the nutrient (protein and crude fiber).

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بعض العناصر الثقيلة في المياه والأسماك وانواع النباتات من شط العرب
في محافظة البصرة - العراق

المستخلص

المعادن الثقيلة تحتوي على تأثير سام بشكل خاص على البيئات المائية. تمت الدراسة في نوفمبر 2018. في أربع محطات تشمل محطتين في الجنوب ومحطتين أخريين في شمال شط العرب في العراق. تراوحت قيم الأس الهيدروجيني بين (7.85-8.89) وكذلك الموصلية الكهربائية من (2.84-3.92) مللي / سم بينما تراوحت الملوحة من (1.81-2.5) PPT (وتم تسجيل هذه القيم عند درجات حرارة تتراوح بين (14-18.2) درجة مئوية ، كان الأكسجين المذاب (6-9.22) ملغم / لتر. تراوحت كمية الأكسجين البيولوجي الذي تم تطهيره بين (1-5) ملغم / لتر. أظهر إجمالي العناصر الثقيلة المذابة اختلافات معنوية في عينات المياه والأسماك والنباتات. في عينات الماء تراوحت قيم الحديد من (9.52-14.97) ملغم / لتر. تراوحت قيم عنصر الخارصين بين (0.48-1.11) ملغم / لتر ، وتراوحت قيم عنصر النحاس بين (0.275 -0.848) ملغم / لتر. في جميع عينات أسماك الجسم ، أظهر عنصر الحديد أن القيم تراوحت بين (11.18-15.83) ملغم / كغم من الوزن الجاف بينما أظهر عنصر الخارصين قيم تتراوح بين (17.306-74.25) ملغم / كغم من الوزن الجاف ، وسجلت قيمة عنصر النحاس مابين (11.45 - 34) ملغم / كغم من الوزن الجاف. كما هو موضح في العينات النباتية، تراوحت قيم عنصر الحديد بين (16.12-42.12) ملغم / كغم من الوزن الجاف بينما تراوحت قيم عنصر الحارصين بين (22.55-142) ملغم / كغم من الوزن الجاف بينما سجل عنصر النحاس قيم تتراوح من (65.875) -94.5) ملغم / كغم من الوزن الجاف. لم يتم اكتشاف الكادميوم والرصاص في

جميع أنواع النباتات. تهدف الدراسة الحالية إلى المقارنة بين نوعية المياه في شمال وجنوب شط العرب ، وتحديداً لبعض المتغيرات الفيزيائية والكيميائية في مناطق معينة ، وكذلك تقدير العناصر الثقيلة في العينات المحددة.