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EFFECT OF GERMINATION OR HEAT TREATMENT OF FENUGREEK SEEDS ON GROWTH AND SOME CARCASS CHARACTERISTICS OF AWASSI LAMBS

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ABSTRACT

The study used 20 Awassi lambs with an average weight of 25.65 ± 3.29 kg and ages between 4-5 months. The lambs in all groups were fed the basal diet without any additives in the first group (control). In the second group, lambs were fed a basal diet in addition to 30 g/lamb of raw fenugreek seeds (RF); in the third and fourth groups, lambs were fed a basal diet with heat-treated (HF) and germinated seeds (GF). The results showed insignificant differences in final body weight and daily gain, feed efficiency was lowered in all fenugreek treatments as compared control, the lambs fed with (HF) had better feed efficiency within fenugreek treatments. Dressing percentage was higher (P≤0.05) in GF (52.47%) as compared to control (49.32%) and RF (48.98%). Back fat thickness decreased in all fenugreek treatments compared to the control. Tail and total fat were not affected significantly with treatments. Fat percent in ribs 9-10-11 was higher (P≤0.05) in RF and HF groups (35.19 and 32.15%) as compared with control (25.32%), while the value in GF (27.32%) was close to the control. In addition, germination and heat treatments of fenugreek seeds led to an alteration in chemical composition and change in bioactive compounds compared to raw seeds. The most critical change observed is the decrease in oxalate compounds in the heat-treated fenugreek compared to other treatments. In conclusion, fenugreek seeds in 30 g/lamb daily had a detrimental effect on productive performance, and treated with heat or germination reduced the adverse impact of raw seeds.

INTRODUCTION

Livestock constitutes one of the essential pillars of a country's economy, including Iraq. It contributes to achieving food security because animal products provide people with their energy and protein needs (Allawi and Hame, 2023), especially in rural regions where many families depend on the production of their animals to provide their daily nutritional requirements (Meunier-Goddik and Nashnush, 2006; Alkass *et al*, 2022). According to the recommendations of the Food and Agriculture Organization (FAO, 2011), there is a need to provide an 80% increase in meat production during the period 2000-2030. This requires increasing the number of animals and providing larger quantities of feed to sustain animal production, as it is known, nutrition in animal production projects plays a pivotal role in achieving economic returns, due to environmental problems represented by global warming and the continuous decline in the land exploited as natural pastures or the agricultural production of crops that feed animals (Alzubaidi, 2024).

Providing the complete daily needs of food compounds at the minimum cost has become challenging, especially among small producers. However, despite this, authors suggest many attempts to improve the efficiency of feed utilization by enzymes, antioxidants, or medicinal plants rich in active substances that add to the rations, which can lead to improved production performance.

Over the past twenty years, the use of medicinal plants in nutrition has become widespread, especially in the Middle East region, as it is a suitable environment for the growth of these plants, one of the most widely used and important of these plants is fenugreek seeds, which is a leguminous plant (Acharya *et al.* 2006). Fenugreek seeds are widely used in human food as a type of flavoring or for therapeutic purposes (Alu'datt *et al*., 2023). Fenugreek leaves contain carbohydrates, proteins, and minerals, especially calcium, as they are low in fat. At the same time, the seeds are rich in proteins, dietary fiber, vitamin C and minerals, especially iron (Wani and Kumer, 2018).

Traditional medicine has shown the effectiveness of fenugreek in the medical prevention and treatment of diseases; the extracts of fenugreek seeds contain antidiabetic, antioxidant, antibacterial, antifungal, immunomodulatory, and antitumor activity (Zean Al-abdomen *et al*., 2010, Al-Nuaimmi and Abdul-Rahman 2018, Al-Moteoty, 2018, and Ibrahim, 2019). Fenugreek also has a perfect effect on the lymphatic system, as it works to facilitate the distribution of nutrients within the cells and remove toxic or residual components due to some hormones and is used to increase milk secretion in humans and animals (Dronca *et al*., & 2018 and Ali, 2018). Also, the response to adding fenugreek seeds on animal performance is not constant. Many studies have indicated a positive effect on production, belonging to active substances such as tannins, flavonoids, and saponins, which can improve digestion and antioxidant status and increase output. The content of mucilaginous substances and galactomannans varies between fenugreek types. It may alter the response to feeding fenugreek seeds (Dronca *et al*., 2018 and Aljumaily and Shamoon, 2023) or an increase in the percentage of active substances beyond the limits that produce a positive effect, which causes a state of confusion in the level of ruminal fermentation and reduces the positive impact.

Many treatments have been proposed to reduce these adverse effects, such as soaking fenugreek seeds in water or germination. Few studies on this subject indicate the possibility of lowering tannins and saponins and increasing the ability to antioxidants. This study was proposed to compare the effect of these treatments (soaked fenugreek, heat treatment, or cultured fenugreek) on the productive performance of Awassi lambs.

MATERIALS AND METHODS

Ethical Approve

Based on the Institutional Animal Care and Use Committee report number: UM.VET.2023.075, dated 1/10/2023, the Scientific Committee accepted the article conducted at the University of Mosul / College of Agriculture & Forestry.

Animals and veterinary treatment

The study was conducted using 20 Awassi lambs with an average weight of 25.65 ± 3.29 kg and ages between 4-5 months, purchased from the local market in Mosul. After the end of the period of preventive veterinary isolation and ensuring that they were free of diseases, the lambs were divided into four groups nearest to their average initial weights. The lambs were housed in a semi-open hall equipped with all the necessary supplies for fattening in addition all lambs were underwent a veterinary health program that included vaccination with the enterotoxemia and injected against internal and external parasites to ensure their safety during the study period.

Diet and Experimental treatment

During the first two weeks, the lambs were gradually fed the standard ration to ensure acclimatization of the rumen microorganisms to the new ration used for feeding during the study period. Table (1) shows the proportions and chemical composition of the standard ration and fenugreek seeds. The lambs in all groups were fed the standard diet, without any additives in the first group, (control). In the second group, lambs were fed a basal diet and 30 g/lamb of raw fenugreek seeds. In the third group, the fenugreek was soaked in water for 3 hours and then treated with heat at 100 Cº for two hours. While in the fourth group, the fenugreek was germinated by soaking in tab water for 12 hours, then washed well with water and placed in plastic containers for 48 hours for germination.

Experimental Procedure and Samples Analysis

The lambs were fed the basic ration in the experimental treatments for two periods daily. The first meal was served at seven in the morning and the second at four in the afternoon. The remaining feed was weighed the next day and subtracted to calculate the actual feed consumed. Fenugreek was also added to the various treatments in the morning to ensure consumption. All the quantity of fenugreek with the feed During the study period, which lasted 90 days, the lambs were weighed every two weeks using a disc scale installed on a special cage for weighing sheep. The lambs were weighed in the last two days to determine the final weights and then slaughtered. The weights of the head, legs, and skin were recorded first, then the weights of the edible parts other than the carcass (heart and liver, lungs, kidneys, testicles, and spleen) were recorded. Also, carcass fat weights were recorded in addition to the tail fat after cutting from the first coccygeal vertebra. The weight of the carcass was recorded, which was later divided into two identical halves, as ribs 9-12 were separated from the left half of the carcass. The longissimus muscle and back fat thickness were calculated between the ribs12-13 according to the procedure of (de Oliveira Cesco *et al*., 2017), as well as physical dissection of ribs 9-10-11 to calculate the fat, muscle, and bone ratio according to the method of (Duckett *et al*., 2007).

Determination of bioactive compound in fenugreek seeds

Vitamin C content in fenugreek seed was determine according the procedure of (Ranganna, 1977). Bioactive compounds of fenugreek seeds GC-MS analysis was carried out on a GC – mass Shimadzu system auto sampler and gas chromatograph interfaced to a mass spectrometer (GC-MS) instrument employing the following conditions: Elite-1 columin of fused silica capillary

column HP-5MS (30 mm×0.25 mm I.D) operating in electron influence mode at 70 eV; helium (99.999%) was used as carrier gas at a constant flow of 1ml/min and an injection volume of 0.5 uL was employed (split ratio of10:1) injector temperature 250 °C; ion-source temperature 280 °C. Oven tempet was programmed from 60°C (isothermal for 2 min), with a rise of 10 °C/min, until 270 °C, then 5 °C/min to 290 °C, ending with a 9 min isothermal at 310 °C. Mass spectra were taken at 70 eV; a scan interval of 0.5 seconds and fragments from 45 to 450 Da. Total GC running time is 60 min.

Table (1) ingredient and chemical composition of basal diet.

Ingredient	Basal diet %	Chemical composition% dry matter	
Crushed white barley	70	Dry matter	90.95
Wheat bran	15	Ash	5.6
Soybean meal	7.5	Crud protein	13.79
Wheat straw	4	Crud fiber	8.02
Urea	0.5	Ether extract	1.44
Sodium chloride	1	Nitrogen free extract	54.63
Sodium bicarbonate	1	Energy Mj/kg	10.13
Calcium carbonate	1		

Chemical analysis of feed stuffs was done using procedure of AOAC (2000). Metabolic energy was calculated according (MAFF 1975).

Statistical Analysis

Statistical analyses of data were done using General Linear Model procedure by completely random design SAS, (2011) by the following model:

$$Y = \mu + Ti + eij$$

Where:

μ= is the overall mean,

Ti= the fixed effect of dietary treatments,

eij= the standard error effect.

The treatment effects were declared at $P \leq 0.05$ using Duncan test (1955).

RESULTS AND DISCSSION

Results of chemical analysis of raw, heat-treated, and germinated fenugreek seeds are shown in Table (2). It appears that germination increased protein (36.75%), crude fiber (35%), and vitamin C content (5.1) mg/100g than raw seeds in which protein was 32.46%, crude fiber 31% and vitamin C 4.5 mg/100g, on the contrary, nitrogen-free extract decreased in germinated seeds than raw 21.53 and 29.54% respectively, other components of ash ether extract and energy were not affected. Also, the rise in dry matter content may be the reason for the changes in the composition of heat-treatment fenugreek seeds, and the reduction in vitamin C may be due to the detrimental effect of heat during treatment. This result was agreed with finding of El-Shimi *et al*., (1984), who reported that vitamin C increased in germinated fenugreek seed than raw seeds, results also was agreed with the data of Pandey and Awathi (2015) when study the composition of fenugreek seeds subjected to the roasted and germination. Ojha *et al*., (2018) reported that protein and vitamin C increased in germinated fenugreek seed than raw seeds, Sharara (2017) fond increment in protein, fiber and ash with germination fenugreek seeds.

Atlaw and Kumar (2018) found an increase in protein as a result of germination for 48 hours with a trend to decrease ash and fat crud fiber. Adhikari and Rai (2021) reported that protein and fiber increased while fat and carbohydrates decreased when fenugreek seed germinated. On the other hand, roasting fenugreek seed did not affect the content of nutrients except for the increase in carbohydrate content.

Table (2) Effect of treatments on chemical composition of fenugreek seeds %.

Traits	Fenugreek seeds		
	Raw	Heat treated	Germination
Dry matter	90.35	92.55	23.68
Ash	3.48	3.08	3.33
Crud protein	32.46	33.58	36.75
Crud fiber	31	29	35
Ether extract	3.52	4.30	3.39
Nitrogen free extract	29.54	30.04	21.53
Energy Mj/kg	10.67	11.00	10.22
Vitamin C mg/100 g	4.5	3.9	5.1

Table (3) indicated that initial body weight was close between treatments 25.75, 26.50, 25.50, and 255.00 kg, respectively. Raw, heat treated, and germinated fenugreek seed addition to the feed intake did not lead to improved final body weight, actually decreased by 45.75, 45.62, and 43.37 kg as compared to control 47.25 kg, especially in germinated treatment, but these differences did not reach significance. Also, no significant differences were noted in total gains of 21.50, 19.25, 20.12, and 18.37 and daily gains of 0.238, 0.213, 0.224, and 0.204, respectively. Feed intake was close within treatments 1.219, 1.215, 1.219, and 1.217 kg/day/lamb, respectively. The lower final weight, total, and daily gain may be due to the adverse impact of fenugreek seed in feed efficiency, which was lowered in all additive groups compared to control 5.103, 5.681, 5.452, and 5.971 kg dry matter/ kg of gain. Al-Saady *et al* (2011) found that using fenugreek seed 7.5% in concentrate feed not effect in final body weight, Al-Issawi (2012) used 400 mg of fenugreek seeds per kg of body weight and mention that supplement did not affect in final body weight, total gain, feed intake and feed efficiency. Our results agreed with Al-Wazeer (2017) when using 0, 2.5, 5, and 7.5 g/lamb of fenugreek seed in feeding Awassi lambs, and insignificant differences were noted in final body weight, total gain, feed intake, and feed efficiency.

Al-Rubaie and Al-Saadoun (2019) use two levels of fenugreek seeds, 3 and 6% of the diet, and mention that lamb's body at weaning significantly increased ($P \leq 0.05$) with an increased level of fenugreek. Bharathy *et al*. (2016) conclude that ewes fed with 10 g of fenugreek seeds per ewe, their lambs had better growth compared to the control treatment. A significant increase in Barki lamb's weight gain fed 30 g/ lamb of fenugreek seeds due to improved feed intake and utilization compared to control (Ismail, 2000). Similarly, Abu El-Kassim *et al*. (2018) found a significant increase in feed intake in ewes during pregnancy but no effect through the lactation period due to feeding with the addition of fenugreek seed compared to control. Ali (2018) found a significant ($P \leq 0.05$) increase in Awassi lambs at weaning in ewes groups fed with 5 and 10% fenugreek seeds in the diets as

compared with the control. When reviewing studies related to fenugreek germination, it was noted Abou-Elenin *et al*. (2016) reported that goat kids' weight at weaning was higher (P≤0.05) when using 10 and 30 g of germinated seed than control and ungerminated fenugreek seeds. The results showed that the enhancement in body gain was associated with responding to the effect of fenugreek on feed intake.

Table (3): Effect of treatment fenugreek seeds in body weight gain and feed efficiency.

Traits	Control	Raw fenugreek seeds	Heat Treated fenugreek seeds	Germinated fenugreek seeds
initial weight (kg)	25.75±2.13	26.50±2.06	25.50±2.32	25.00±1.22
Final weight (kg)	47.25±3.32	45.75±2.86	45.62±2.15	43.37±1.72
Total body weight gain (kg)	21.50±1.19	19.25±0.62	20.12±0.65	18.37±0.62
Daily body weight gain (kg)	0.238±0.01	0.213±0.00	0.224±0.00	0.204±0.00
Dry matter intake kg/day	1.219	1.215	1.219	1.217
Feed efficiency DM intake kg/gain	5.103	5.681	5.452	5.971

Data in table (4) illustrated that carcass weight was similar between treatments 23.26, 22.42, 23.23 and 22.77 kg, although the final weight in treatments fed with addition fenugreek seeds was decreased 2-4 kg as compared control, but carcass weight was close this is reflected by the improve dressing percentage significantly (p≤ 0.05) in T3 and T4 that fed with (HF) and (GF) seeds 50.85 and 52.47% compared lambs fed with addition (RF) seed 48.98% and control 49.32%, while the differences was not reach to significance in T1 and T3. The degree of muscularization in the body, which is inferred from measuring the Longissimus muscle area was better in the control treatment compared to the additive treatments, but it was not significant 14.00, 12.66, 13.00 and 13.00 cm^2.

Table (4): Effect of fenugreek seeds treatments in carcass weight, longissimus muscle area and back fat thickness.

Traits	Control	Raw fenugreek seeds	Heat Treated fenugreek seeds	Germinated fenugreek seeds
Carcass weight (kg)	23.26±1.51 a	22.42±1.55 a	23.23±1.32 a	22.77±1.03 a
Dressing percentage (%)	49.32±0.57 bc	48.98±0.69 c	50.85±0.64 ab	52.47±0.34 a
Longissimus muscle area (cm^2)	14.00±1.00 a	12.66±0.88 a	13.00±1.15 a	13.00±1.15 a
Back fat thickness (mm)	6.66±0.66 a	2.50±0.28 b	4.00±0.57 b	2.50±0.28 b

Different letters within row indicate significant differences (P≤0.05).

On other hand we found that feeding raw heat treated and germinated fenugreek seeds led to a significant decreased in back fat thickness 2.50, 4.00 and 2.50 mm in comparison with control 6.66 mm. We found in previous studies Salama *et al.,* (2015) insignificant differences in warm carcass weight and dressing percentage in goat kids fed fenugreek seeds as compared control. As well as, agreed with Van Wyk, (2022) who indicated that feeding 120 g of fenugreek seed to the

buffalo had no significant differences as compared control in carcass weight and dressing percentage. Unlike Al-Saady *et al.*, (2011) indicated presence a significant (P≤0.05) increase in carcass weight in the group of fenugreeks compared to the control in addition longissimus muscle area and back fat increased significantly du the effect of fenugreek seed in improve feed utilization and protein anabolic.

The results in the table (5) showed that RF seeds led to a non-significant increase in the weight of tail fat by 31.34% compared to the control treatment, while the percentage decreased in tail fat weight due to fenugreek seeds heat and germination treatments to 24.17 and 17.61%, respectively compared to the control treatment. Also, it is clear from the results that omental fat deposition was highest in the raw fenugreek treatment 363.33 g with a non-significant difference compared to the control treatment 330.00 g, while it was significantly higher (P≤0.05) as compared to the treatments that were fed with the addition of heat-treated and germinated fenugreek seeds (263.33 and 286.67 g) respectively. Likewise, we find that the deposition of mesenteric fat was significantly higher (P≤0.05) in the raw fenugreek treatment 478.33 g as compared control 325.00 g and heat-treated fenugreek seeds 260.00 g, in which the lowest value was recorded. Feeding Germinated fenugreek seeds led to significant increase (P≤0.05) in mesenteric fat 421.67 g than lambs fed heat treated fenugreek seeds.

A significant decrease (P≤0.05) was recorded in the weight of kidney and pelvic fat in the heat-treated fenugreek seeds 81.67 g compared to the other treatments 186.67, 175.00 and 158.55 g. Heart fat weight increased significantly (P≤0.05) when fed with the addition of sprouted fenugreek 55.00 g as compared to raw fenugreek 36.66 g, while the differences were not significant with the other treatments. In general, we find that the weight of total fat 4.230, 5.460, 4.45 and 4.86 kg, respectively. Its percentage to the weight of the carcass 19.18, 24.90, 19.65 and 20.71% did not differ significantly between the treatments. However, feeding raw fenugreek seeds led to a higher percent of total fat and exposing fenugreek to heat or sprouting resulted in carcasses with a percentage of total fat close to control. It is clear from the above that feeding fenugreek seeds in their raw state leads to the deposition of a larger amount of fat in the body, and this may be related to a decrease in the efficiency of feed utilization, since the deposition of one kilogram of fat requires a greater amount of energy compared to the deposition of muscle (Alkass *et al*, 2023), and the deposition of fat is concentrated in the tail and abdominal. On the other hand, heat treatment of fenugreek seeds led to a change in the mechanism of fat deposition mainly, this has a good economic income, when considering that the price of tail fat has a high marketing value compared to other fats. In the study of (Salem *et al.*, 2004) results showed no significant effect of fenugreek seeds in lamb's diet in internal fats than control, in contrast Al-Saady *et al* (2011) who reported that using 2% fenugreek seed in lambs diet had no significant effect in mesenteric and kidney fat. Alzaidan *et al*, (2022) noticed that total fat percent was 18.68% when carcasses weight was 25 kg in awassi lambs, this value was near to the pecent of total fat that found in our study on awassi lambs.

Table (5): Effect of fenugreek seeds treatments in carcass fat.

Traits	Control	Raw fenugreek seeds	Heat Treated fenugreek seeds	Germinated fenugreek seeds
Tail fat (kg)	3.350±0.36 a	4.400±0.59 a	4.160±0.66 a	3.940±0.12 a
Omental fat (g)	330.00±30.55 ab	363.33±29.48 a	263.33±11.66 b	286.67±10.92 ab
Mesenteric fat (g)	325.00±35.11 bc	478.33±38.76 a	260.00±30.41 c	421.67±20.27 ab
Pelvic and kidney fat (g)	186.67±15.89 a	175.00±16.07 a	81.67±13.01 b	158.33±10.13 a
Heart fat (g)	41.66±3.33 ab	36.66±4.40 b	41.66±4.40 ab	55.00±5.00 a
Total fat weight (kg)	4.23±0.39 a	5.46±1.02 a	4.45±0.58 a	4.86±0.66 a
Total fat percentage of carcass weight	19.18±0.91 a	24.90±4.39 a	19.65±1.35 a	20.71±1.67 a

Different letters within row indicate significant differences (P≤0.05).

Table (6) shows the results of the physical dissection of rib 9-10-11, as the proportion of fat increased significantly (P≤0.05) in the lambs that were fed with the addition of raw fenugreek 35.19% compared to the control 25.60% or those that fed with the addition of germinated fenugreek 27.32%. Still, it did not reach significance compared to those that ate heat-treated fenugreek 32.15%, which was also significantly higher than the control; the distribution of muscle proportions was opposite to the fat proportion. Although there were differences between the treatments, they did not reach the significance level of 44.80, 39.83, 40.63, and 43.37%, respectively. Bone proportions were 28.51, 25.22, 25.84, and 28.38%, unaffected significantly by treatments.

Table (6): effect of fenugreek seeds treatments in the 9-10-11 ribs tissues proportion

Traits	Control	Raw fenugreek seeds	Heat Treated fenugreek seeds	Germinated fenugreek seeds
Fat proportion	25.60±2.23 c	35.19±1.18 a	32.15±1.74 ab	27.32±0.67 bc
Muscle proportion	44.80±2.76 a	39.83±1.63 a	40.63±1.97 a	43.37±2.26 a
Bones proportion	28.51±1.91 a	25.22±0.85 a	25.84±2.36 a	28.38±2.66 a
Muscle: fat proportion	1.75±0.28 a	1.13±0.09 b	1.23±1.14 b	1.53±0.06 ab
Muscle: bone proportion	1.55±0.30 a	1.57±0.08 a	1.57±0.12 a	1.56±0.23 a

Different letters within row indicate significant differences (P≤0.05).

As a result, to increase fat proportion in treatments fed with raw and heat-treated fenugreek seeds, muscle to fat ratio decreased significantly (P≤0.05) to 1.13

and 1.23 as compared to control 1.75, while feeding with germinated seeds gave a muscle-to-fat ratio of 1.53 close to the control. Muscle-to-bone ratios were close between treatments: 1.55, 1.57, 1.57, and 1.56. respectively. Our results did not agree with Salem *et al*. (2004) and Al-Saady *et al*. (2011), who reported a significant increase in lean, fat, and bone percent in lambs carcass-fed fenugreek seeds compared to control. Salem *et al*. (2015) noticed no considerable effect of fenugreek seeds on fat and protein percent in goat kids' meat.

Results in Tables (7,8 and 9) of the GC-MS technique of the determination of bioactive compounds in methanolic extract of raw fenugreek seeds indicated the presence of fifteen retention times included many metabolic compounds, of which oxalate or oxalic acid that as well as other compounds with antibacterial and therapeutic effects. This is what was obtained also in the methanolic extract of germinated fenugreek, with a decrease in the number of retention times of eight compared to raw fenugreek, and this is undoubtedly a result of the culture process and its effect on the metabolism of compounds in fenugreek seeds. Several oxalate compounds were also obtained in the cultured fenugreek. On the other hand, heat treatment of the fenugreek seeds after soaking in water led to the appearance of eight. Retention time was also affected, but the heat treatment affected the quality of the compounds obtained, as the oxalate compounds decreased significantly. This effect of the heat treatment may be a reason for reducing the negative impact observed for raw and germinated fenugreek seeds on the efficiency of food utilization and weight gain, which was less than the control treatment, as it may reduce the effect of oxalate on nutrients absorption from the intestine, or perhaps the effect of other active compounds on rumen bacteria. This effect may also be because heat treatment reduces the decomposition of fenugreek seeds in the rumen and releases active compounds with antibacterial activity. In this context, Singh *et al*. (2023) indicated that heat treatment of fenugreek leaves significantly reduces anti-nutrients from oxalate. Through comparison with previous studies, we find that fenugreek contains many bioactive compounds that have an antibacterial and anti-oxidant effect or compounds that have a therapeutic effect (Shashikumar *et al*., 2018; Bouhenni *et al*., 2021; Kumer *et al*., 2021).

Table (7): Bioactive compounds in raw fenugreek seeds.

Peak no.	Retention time	Chemical name	formula	Molecule weight
1	5.550	11H-Naphtho[1,2-b]thieno[3,4-d]pyran-11-one, 1-amino-3-methyl-	C16H11NO2S	281
		1-[2,4-Bis(trimethylsiloxy)phenyl]-2-[(4-trimethylsiloxy)phenyl]propan-1-one $$ 1-[2,4-Bis(trimethylsilyloxy)phenyl]-2-[(4-trimethylsily	C24H38O4Si3	474
		1-Pentene, 4,4-dimethyl-1,3-diphenyl-1-(trimethylsilyloxy)-	C22H30OSi	338
		1-Heptene, 1,3-diphenyl-1-(trimethylsilyloxy)-	C22H30OSi	338
		Ethyl3-(6-methoxy-3-methyl-2-benzofuranyl)-3-(p-methoxyphenyl)propionate	C22H24O5	368
2	6.375	Neopentane	C5H12	72
		Propanoic acid, 2-propenyl ester	C6H10O2	114
		Oxalic acid, butyl isobutyl ester	C10H18O4	202
		Butane, 2,2,3,3-tetramethyl-	C8H18	114

Peak no.	Retention time	Chemical name	formula	Molecule weight
		Oxalic acid, bis(isobutyl) ester	C10H18O4	202
3	6.942	Oxalic acid, butyl propyl ester	C9H16O4	188
		Oxalic acid, isobutyl propyl ester	C9H16O4	188
		Propane, 1-bromo-2,2-dimethyl-	C5H11Br	150
		Butane, 2,2,3-trimethyl-	C7H16	100
		Pentane, 2,2-dimethyl	C7H16	100
4	8.192	Oxalic acid, isobutyl propyl ester	C9H16O4	188
		Sulfone, butyl isopropyl	C7H16O2S	164
		anti-2-Acetoxyacetaldoxime	C4H7NO3	117
		Di-tert-butyl peroxide	C8H18O2	146
		2,3-Pentanedione	C5H8O2	100
5	9.400	Octanoic acid, 2-chlorophenyl	C14H19ClO2	254
		Octanoic acid, 3,5-difluorophenyl ester	C14H18F2O2	256
		Nonanoic acid, 2-oxo-, methyl ester	C10H18O3	186
		Carbamic acid, N-(4-chlorophenyl)-, heptyl ester	C14H20ClNO2	269
		4-Nitrophenyl caprylate	C14H19NO4	265
6	10.525	Oxalic acid, butyl propyl ester	C9H16O4	188
		Oxalic acid, isobutyl propyl ester	C9H16O4	188
		Oxalic acid, heptyl propyl ester	C12H22O4	230
		Hexane	C6H14	86
		Oxalic acid, isobutyl pentyl ester	C11H20O4	216
7	10.925	Oxalic acid, isobutyl propyl ester	C9H16O4	188
		Di-tert-butyl peroxide	C8H18O2	146
		Trimethylaluminum	C3H9Al	72
		Propane, 1-bromo-2-methyl	C4H9Br	136
		2-Butanone, 3,3-dimethyl-	C6H12O	100
8	11.892	1-Phenyl-2-butanone	C10H12O	148
		5H-Imidazo[4,5-b][1,2,5]oxadiazolo[3,4-E]pyrazin-6(7H)-one	C5H2N6O2	178
		Thiolane-3,3,4,4-tetracarbonitrile, 2,5-di-tert-butyl-	C16H20N4S	300
		s-Triazolo[4,3-a]pyridine, 3-amino-6-methyl-	C7H8N4	148
		2-Butanone, 3,3-dimethyl-	C6H12O	100
9	13.567	Butane, 2,2-dimethyl-	C6H14	86
		Oxalic acid, isobutyl pentyl ester	C11H20O4	216
		Hexane	C6H14	86
		Oxalic acid, isobutyl octyl ester	C14H26O4	258
		Octane, 3,6-dimethyl	C10H22	142
10	15.050	Pentane, 2,4-dimethyl	C7H16	100
		Butane, 1-propoxy	C7H16O	116
		1-Propanol, 2,2-dimethyl-, acetate	C7H14O2	130
		Pentane, 1,3-epoxy-4-methyl-	C6H12O	100
		Oxalic acid, butyl propyl ester	C9H16O4	188
11	16.750	Oxalic acid, isobutyl propyl ester	C9H16O4	188
		Oxalic acid, butyl propyl ester	C9H16O4	188
		Oxalic acid, heptyl propyl ester	C12H22O4	230
		Propane, 1-bromo-2-methyl	C4H9Br	136
		2-Butanone, 3,3-dimethyl-	C6H12O	100
12	17.742	2-Phenyl-2H-[1,2,3]triazolo[4,5-d]pyrimidin-7-ol	C10H7N5O	213
		7-Phenyl-4-hydroxy-7H-pyrazolo[3,4-d]S-triazine	C10H7N5O	213
		2-Amino-6-benzyloxytoluene	C14H15NO	213
		6-Phenylamino-1,2,4-triazolo[4,3-	C9H7N7	213

Peak no.	Retention time	Chemical name	formula	Molecule weight
		b][1,2,4,5]tetrazine		
		N-(4-Methoxy-2,5-dinitrophenyl)acetamide	C9H9N3O6	255
13	19.300	n-Hexadecanoic acid	C16H32O2	256
		alpha.-D-Mannopyranoside, methyl 3,6-anhydro-	C7H12O5	176
		1-Butanol, 3-methyl-	C5H12O	88
		4-Methyloctanoic acid	C9H18O2	158
		3-Ethylheptanoic acid	C9H18O2	158
14	21.125	Pentanenitrile, 4-methyl-	C6H11N	97
		4,8-Dioxaspiro[2.5]oct-1-ene, 6,6-dimethyl-	C8H12O2	140
		2,3-Epoxyhexanol	C6H12O2	116
		Oxalic acid, cyclobutyl heptyl ester	C13H22O4	242
		Oxalic acid, cyclobutyl octyl ester	C14H24O4	256
15	24.992	Bumetrizole	C17H18ClN3O	315
		4-Cyano-1-diphenylmethylsilyloxybenzene	C20H17NOSi	315
		1-Ethanone, 1-[4-acetyl-1-(2,5-dimethoxyphenyl)-2,5-dimethyl-1H-pyrrol-3-yl]-	C18H21NO4	315
		Conanine, (5.alpha.)-	C18H21NO4	315
		N-Cyclohexyl-3-(1,3-dioxo-1H,3H-benzo[de]isoquinolin-2-yl)-benzamide	C25H22N2O3	398

Table (8): Bioactive compound in germinated fenugreek seeds

Peak no.	Retention time	Chemical name	Formula	Molecule weight
1	10.517	Oxalic acid, isobutyl propyl ester	C9H16O4	188
		Oxalic acid, heptyl propyl ester	C12H22O4	230
		Di-tert-butyl peroxide	C8H18O2	146
		Propanoic acid, ethenyl ester	C5H8O2	100
		Heptane, 1-iodo-	C7H15I	226
2	13.558	Oxalic acid, isobutyl propyl ester	C9H16O4	188
		Di-tert-butyl peroxide	C8H18O2	146
		Oxalic acid, butyl propyl ester	C9H16O4	188
		Heptane, 1-iodo-	C7H15I	226
		Trifluoroacetyl-di-butylphosphin	C10H18F3OP	242
3	13.908	Propanamide, 2,2-dimethyl-N-(2'-t-butylcarbonylphenyl)-	C16H23NO2	261
		1-[(2-Bromo-phenyl)-(2,2-dimethyl-propionyloxy)-methyl]-3,4-dihydro-1H-isoquinoline-2-carboxylic acid, ethyl ester	C24H28BrNO4	473
		4-(2-t-Butyl-5-oxooxazolidine-3-carbonyl)-N,N-diethylbenzamide	C19H26N2O4	346
		Benzo[1,2-c:3,4-c':5,6-c"]tris[1,2,5]oxadiazole	C6N6O3	204
		Thieno[2,3-b]quinolin-3-amine, 5,6,7,8-tetrahydro-2-octylsulfonyl-	C19H28N2O2S2	380
4	15.050	7-Acetoxy-4-methylcoumarin	C12H10O4	218
		5-Fluorotryptophan	C10H18F3OP	242
		1,4-Methanonaphthalene-5,8-diol, 1,2,3,4-tetrahydro-	C11H12O2	176

Peak no.	Retention time	Chemical name	Formula	Molecule weight
		[1,2,4]-Triazolo[2,3-a]pyrimidine-2-carboxylic acid, 5,7-dimethyl-, butyl ester	C12H16N4O2	248
		8-acetyl-7-hydroxy-4-methyl-	C12H10O4	218
5	17.733	2H,8H-Benzo[1,2-b:5,4-b']dipyran-2-one, 8,8-dimethyl-	C14H12O3	228
		Carbanilic acid, p-phenyl-	C13H11NO2	213
		5-Acetyl-4-(2-furyl)-4,5,6,7-tetrahydro-6-hydroxy-3,6-dimethyl-1H-benzindazole	C15H18N2O3	274
		Diphenolic acidhydroxyphenyl)-.gamma.-methyl-	C17H18O4	286
		4-Adamantan-1-yl-2-(2-methylpropane-2-sulfonyl) pyridine	C19H27NO2S	333
6	19.275	(S)-(+)-3-Methyl-1-pentanol	C6H14O	102
		2,2-Dimethyl-3-hydroxypropionaldehyde	C5H10O2	102
		1-Hexene, 5-methyl-	C7H14	98
		Oxalic acid, cyclobutyl heptyl ester	C13H22O4	242
		Hydroperoxide, hexyl	C6H14O2	118
7	21.100	Diazirine	CH2N2	42
		Ketene	C2H2O	42
		Methane, diazo-	CH2N2	42
		Cyclopropane	C3H6	42
		1H-Tetrazole	CH2N4	70

Table (9): Bioactive compound in heat treated fenugreek seeds.

Peak no.	Retention time	Chemical name	Formula	Molecule weight
1	8.142	2,7-Diphenyl-1,6-dioxopyridazino[4,5:2',3']pyrrolo[4',5'-d]pyridazine	C20H13N5O2	355
		Trimethylsilyl)methyl stearate(	C22H46O2Si	370
		Benzoic acid, 2,3-bis[(trimethylsilyl)oxy]-, trimethylsilyl ester	C16H30O4Si3	370
		Benzoic acid, 2,6-bis[(trimethylsilyl)oxy]-, trimethylsilyl ester	C16H30O4Si3	370
		N-(Trifluoroacetyl)-N,O,O',O"-tetrakis(trimethylsilyl)norepinephrine	C22H42F3NO4Si4	553
2	10.467	1-Butene	C4H8	56
		Borane, ethyldimethyl-	C4H11B	70
		o-Allylhydroxylamine	C3H7NO	73
		1-Propene, 2-methyl-	C4H8	386
		trimethyl-	C3H9B	56
3	10.767	Estra-1,3,5(10)-trien-17-one, 2-[(trimethylsilyl)amino]-3-[(trimethylsilyl)oxy]	C24H39NO2Si2	429
		Estra-1,3,5(10)-trien-17-one, 2,3-bis[(trimethylsilyl)oxy]-	C24H38O3Si2	430
		3H,3'H,3"H-Trisindeno[1,2-a:2',1'-c:1",2"-e]benzene	C27H18	342
		Lorazepam ditms	C21H26Cl2N2O2Si2	464

Peak no.	Retention time	Chemical name	Formula	Molecule weight
		9,10-Anthracenedione, 1-(methylamino)-4-[(4-methylphenyl)amino]-	C22H18N2O2	342
4	17.733	4-Adamantan-1-yl-2-(2-methylpropane-2-sulfonyl) pyridine	C19H27NO2S	333
		Pyridine-3-amine, N-(3,4-dihydroxybenzylidene)-	C12H10N2O2	214
		Carbanilic acid, p-phenyl-	C13H11NO2	213
		2-Phenyl-2H-[1,2,3]triazolo[4,5-d]pyrimidin-7-ol	C10H7N5O	213
		7-Phenyl-4-hydroxy-7H-pyrazolo[3,4-d]S-triazine	C10H7N5O	213
5	21.117	Pentanenitrile, 4-methyl-	C6H11N	97
		2,3-Epoxyhexanol	C6H12O2	116
		4,8-Dioxaspiro[2.5]oct-1-ene, 6,6-dimethyl-	C8H12O2	140
		6-Oxabicyclo[3.1.0]hexane	C5H8O	84
		tert-Butyl acrylate	C7H12O2	128
6	22.450	Phenol, 2,6-bis(bicyclo[2.2.1]hept-2-yl)-4-(1,1-dimethylethyl)-	C24H34O	338
		Indole-3-carboxylic acid, 5-methoxy-2-methyl-1-(3-methylphenyl)-, ethyl ester	C20H21NO3	323
		5,7,4'-Trihydroxy-8-(3,3-dimethylallyl)isoflavone	C20H18O5	338
		Butylphosphonic acid, di(2-chlorophenyl) ester	C16H17Cl2O3P	358
		2-(4-Aminophenyl)-4,6-diphenylpyrimidine	C22H17N3	323
7	24.983	Bumetrizole	C17H18ClN3O	42
		Conanine, (5.alpha.)-	C22H37N	42
		4-Cyano-1-diphenylmethylsilyloxybenzene	C20H17NOSi	42
		1-Cyano-4-diphenyl(tert-butyl)silyloxybenzene	C23H23NOSi	42
		1-Ethanone, 1-[4-acetyl-1-(2,5-dimethoxyphenyl)-2,5-dimethyl-1H-pyrrol-3-yl]-	C18H21NO4	70
8	25.967	Oxalic acid, isobutyl octyl ester	C14H26O4	258
		Decane, 2,5,9-trimethyl-	C13H28	184
		Heptane, 2,3,6-trimethyl-	C10H22	142
		Heptane, 2,3,5-trimethyl-	C10H22	142
		Hexane, 3-ethyl-2,5-dimethyl-	C10H22	142

CONCLUSIONS

The results showed raw fenugreek seeds supplement had no beneficial effect on animals performance, which may be the reason was the quantity used in this study was high, However, it can change fat deposition in the carcasses. On other hand treated fenugreek seeds with germination or heat may reduce or shift the bioactive compounds content and have more benefact effect on carcass yield and fat deposition, this could enhance animals' response to the bioactive compounds through the reduce of the content of oxalate and increase content of vitamin C as compared raw fenugreek seeds.

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CONFLICT OF INTEREST

The authors provide evidence that this work declare no conflict of interest.

تأثير الإنبات أو المعالجة الحرارية لبذور الحلبة في النمو وبعض صفات الذبيحة للحملان العواسية

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الخلاصة

أجريت الدراسة باستخدام 20 حملاً عواسياً بمتوسط وزن 25.65 ± 3.29 كغم، وأعمارها ما بين 4–5 أشهر، غذيت الحملان في جميع المجموعات على العليقة القياسية دون أي إضافات في المجموعة الأولى (السيطرة). المجموعة الثانية غذيت على العليقة القياسية بالإضافة إلى 30 جرام/حمل من بذور الحلبة الخام، في المجموعة الثالثة تم نقع الحلبة في الماء لمدة 3 ساعات ثم عوملت بالحرارة على درجة حرارة 100مْ لمدة ساعتين. بينما في المجموعة الرابعة تم إنبات الحلبة لمدة 48 ساعة. تبين من النتائج وجود فروق غير معنوية في الوزن النهائي والزيادة الوزنية اليومية، كما انخفضت كفاءة التحويل الغذائي في جميع معاملات الحلبة مقارنة بالسيطرة، وكانت الحملان التي بالحلبة المعاملة بالحرارة ذات كفاءة تحويل غذائي افضل من بين جميع معاملات الحلبة وكانت نسبة التصافي أعلى ($P\leq0.05$) في معاملة الإنبات 52.47% مقارنة بالسيطرة 49.32% والحلبة الخام 48.98%، كما انخفض سمك الدهن تحت الجلد ($P\leq0.05$) في جميع معاملات الحلبة مقارنة بالسيطرة. لم يتأثر وزن الالية ونسبة الدهن الكلي بالذبيحة معنويا بالمعاملات التجريبية، وكانت نسبة الدهن في الأضلاع 9–10–11 أعلى ($P\leq0.05$) في البذور الخام والمعاملة حرارياً 35.19 و32.15% على التوالي مقارنة بالسيطرة 25.32% ، بينما كانت متقاربة في معاملة البذور المنبتة 27.32% مع السيطرة،. لوحظ تغير في التركيب الكيميائي لبذور الحلبة نتيجة للمعاملة بالانبات والحرارة، اذ تبين من نتائج تحليل المستخلص الميثانولي انخفاض عدد القمم والمركبات النشطة بيولوجيا مقارنة بالبذور الخام، ومن أهم التغيرات الملحوظة هو انخفاض مركبات الأوكسالات في الحلبة المعاملة حراريا مقارنة بالمعاملات الأخرى، ان استخدام الحلبة بكمية 30 غم/ حمل تؤثر سلبا في الأداء الإنتاجي وان المعاملة بالحرارة او الانبات يقلل من التاثير السلبي لبذور الحلبة الخام.

الكلمات المفتاحية: مركبات فعالة، معاملة بذور الحلبة، أداء انتاجي، حملان.

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