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Research Article
Productive Effects and Economical Feasibility of Substitution Barley by 10 and 30% of Sprouted Barley in Diet of Awassi Male Lambs

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Abstract

Background and Objective: Hydroponic sprouted barley produced from barley grains having high germination rate, grown for a short period of time in a special method that provides appropriate growing conditions. Present study is aimed to cultivated and produce sprouted barley under local conditions and estimated its effects at a levels of 10 and 30% in diet of Awassi male lambs and revealed its effects on chemical compositions alteration, some blood parameters, productivity traits and economical feasibility. **Materials and Methods:** The production plan was designed for 120 days period, using hydroponic steel chamber. Barley seeds were cleaned, washed, soaked and spread on the trays in order to implantation by hydroponic system and water irrigation, lambs is with average body weight of 19.25±0.25 kg and 4 month ages was split into 3 groups, 6 to each. All groups were daily feed with 2% b.wt., of concentrate diet, the amount of feed daily recorded, dry matter intake and feed conversion ratio calculated by weekly. Body weight also, biweekly recorded. One way ANOVA test were conducted to compare the means of each treatment, data were analyzed by using SPSS statistical. **Results:** The chemical analysis revealed significantly higher value in barley grains in comparative to sprouts, but in organic matter and acid detergent fiber chemical analysis values were appeared non-significantly, in blood parameters evaluation, both treated groups particularly 30% group recorded higher values compare to control group. In productive trail the total concentrate diet consumed by each animal in different groups were 63.00, 68.760 and 59.04 kg for groups 10 and 30% and control, the amount of concentrate diet consumed by each animals without sprouts in different groups were 60.48, 60.48 and 59.04, respectively, while the total amount of the sprouts in treated groups were 2.520 and 8.28 kg, then, the total price are 132.96, 192.24 and 96.96 in Iraqi Dinar/1000, thus the total profit for each group are 84.68, 141.96 and 61.51 Iraqi Dinar/1000 for 10 and 30% and control group, respectively. **Conclusion:** According to these results it could be recommend to substituted more high than present percentages of sprouted barley those used in present study to the diet of ruminants and lambs for more economic profit and to improvements productive traits.

Key words: Hydroponic system, blood parameters, irrigation, total protein, ruminants, productive

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Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Hydroponics is an advanced technology in agriculture can meet the growing nutrients requirement for livestock feed with suitable prices sprouted barley is produced from forage grains having high germination rates and grown for short periods of time that control the appropriate growing conditions[1]. Hydroponic fodder systems are usually used to sprout cereal grains and barley is the most commonly grown fodder, because it usually gives the best yield of nutrients[2]. Nutritional requirements of livestock are based on dry matter intake, if fed to livestock at a rate of 2% of their body weight[3]. Over the years, in many different countries with different species (mostly cattle, pigs and poultry), study trials have been conducted to assess the performance of livestock fed hydroponic green fodder[2]. Al-Saadi and Al-Zubiadi[4] reported that there is more than 4 fold increase in weight from 1 kg barley grain. Finney[5] and Grigorev *et al.*[6] revealed an increased performance for both ruminants and mono-gastric animals feed hydroponic barley. Some workers using cattle reported an improvement in performance due to feeding sprouted barley compared to the original unsprouted grain[7,8]. It is well documented that feed costs make more than 75% of total production costs of sheep projects[9]. Since, there is a limited study has been conducted to determine the cost and feeding value of hydroponic barley fodder[10,11]. The majority of sheep raised locally in Iraq is the Awassi breed therefore, the present study designed to assess the costs of feeding hydroponically sprouted barley and the average daily gain and determine the economical feasibility of substitution barley using two different levels, 10 and 30% of sprouts in diet of Awassi male lambs.

MATERIALS AND METHODS

Experimental design: Present study was conducted for 120 days period, at animal farm subsequent to College of Veterinary Medicine/Baghdad University, 18 Awassi male lambs purchased from local trusted farms with average body weight of 19.25±0.25 kg and 4 months ages at the start of the experiments. Experimental lambs treated with anti-ecto and endo-parasites and vaccinated against enterotoxaemia, they were weighed and ranked according to live weight. Then herd split into 3 groups based upon their weight at the start of the trial 6 lambs in each after 2 weeks of adaptation period. All groups were daily feed with 2% of body weight of concentrate diet, the control group were daily fed only this percentage, the second, third groups of lambs were fed with same amount of concentrate diet include 10 and 30% of fresh sprouting barely respectively (Table 1). The amount of feed offered to the lambs and the remaining were weighed all groups supplied with water and mineral blocks.

Each kilogram of vitamin and mineral mixture contained 0.30 g $CoSO_4$, 20.1 g $CuSO_4$, 10 g $FeSO_4$, 50 g ZnO_2, 40.2 g $MnSO_4$, 0.75 g KI, 878 g NaCl, 500,000 IU vitamin A, 500,000 IU vitamin D and 10,000 IU vitamin E, according to AOAC[12].

Fresh sprouted barley daily feed intake for each lambs calculation:

$$\frac{\text{Body weight (kg)}\times 2\%}{100} = \text{(N) kg concentrate diet daily feed intake}$$

$$\frac{\text{(N)}\times 10 \text{ or } 30\%}{100} = \text{(kg) of dry weight of sprouted barely}$$

Sprouts barley production: Hydroponic cultivation and chemical analysis of sprouted grain used according to Peer and Leeson[10]. The forages production plan was conducted using one of hydroponic steel chamber, with dimensions of 2.0 m in length×2.0 m in height×1.0 m in width (Fig. 1), designed to carrying 21 perforated steel trays by 7 shelves, 3 trays to each, with capacity of 7 growth stages by rely of 7 days, trays were used to germinate barley seeds with dimensions of 100 cm in length X40 cm in width and 5 cm in

Table 1: Formulation of experimental dietary concentrate composition (%)

	Ingredients percentage of treatments		
Items	Control	10%	30%
Barley grain	40	30	10
Fresh sprouting barely	0	10	30
Wheat bran	38	38	38
Yellow corn	20	20	20
Mineral and vitamin	2	2	2
Total	100	100	100

Fig. 1: Hydroponic steel chamber carry trays

Fig. 2: Carpet like appearance of barley grass, seedling growth, dark green color and thick roots

Table 2: Chemical composition of HB and grain (DM% basis)

Items	Grain barley	Sprouted barley	Significant
Dry matter	90.40±2.44[a]	14.61±0.43[b]	*
Moisture	9.20±0.45[b]	82.74±0.54[a]	*
Ash	3.10±0.32	4.15± 0.85	-
Organic matter	92.60±0.12	93.25±0.15	ns
Ether extract	1.90±1.28[b]	3.25±1.34[a]	*
Crude protein	9.45±0.32[b]	15.58±0.18[a]	*
Non protein	2.35±1.21[b]	4.80±1.84[a]	*
Nitrogen true protein	5.10±0.49[b]	7.55±0.76[a]	*
Neutral detergent fiber	32.50±1.20[b]	36.35±0.33[a]	*
Acid detergent fiber	7.90±0.35	8.45±0.28	ns
Non fiber carbohydrate	56.55±1.456[a]	51.63±0.34[b]	*

[a-c]Means with different superscripts in the same row are significantly different at $p<0.05$

height to each, equipped with manual sprayer irrigation water and electric air ventilation, the condition inside the rome chamber was controlled to get a range of temperature 18-20°C and relative humidity about 72% by air circulating. Fluorescent lighting with watertight appliance were provide on the wall in the vertical position to growing leaves in which supply about 1000 µW/3 cm during 9-12 h of daily light. Barley seeds (*Hordeum vulgare* L.) were got from a local supplier, which were cleaned, washed and soaked by tap water, putting in container for 24 h, then spread on the trays with 1.1 kg and 2 cm thickness for each and stayed for 7 days. At end of this period, the grass of barley seedling growth reaches about of 16-18 cm in height. It has carpet like appearance with dark green color and thick roots (Fig. 2). Three green grass carpets were removed every day, they required 7 days for each one cycle of seeds germination and continues daily harvesting of green forages, the removal carpets exposed to air ventilation for 24 h in order to more drying, then weighing and calculated before shredded to small pieces mixing with concentrate diets.

Chemical analysis: Weekly samples of green forage diets collected and kept frozen until chemical analysis for crude protein, crude fiber, crude fat and nitrogen free extract according to AOAC[13] (Table 2). The feed sampled and composted daily taken until the end of the collection period. Which were grounded through a 1 mm screen hammer mill and analyzed for DM (at 70°C) and nutrients composition according to AOAC[12] and Henry[14]. Blood samples were collected from jugular vein, serum was obtained after centrifugation at 3000 rpm stored at -200°C till analysis and used to determine total serum protein according to Armstrong and Carr[15], albumin according to Doumas *et al.*[16], globulin was obtained by subtracting the albumin values from the total proteins, creatinine estimate according to Henry[14] and urea according to Patton and Crouch[17]. Blood serum analysis was conducted using jenway spectrophotometer (UK) and using kits purchased from human Co. (Germany).

Performance trail: The concentrate ingredients were prepared and combined weekly, while the roughage and concentrate were mixed manually every day and fed as Total Mixed Ration (TMR), feed and water were offered twice a day, at 9:00 am and 15:00 pm. The amount of feed offered recorded daily, dry matter intake and feed conversion ratio were calculated by weekly. Body weight biweekly were recorded and daily feed intake calculated.

Statistical analysis: One way ANOVA tests were used to compare the means of each treatment by Snedecor and Cochran[18], data were analyzed using SPSS, statistical analysis-version 19 (2010).

RESULTS AND DISCUSSION

Table 2 shows that, there are many significant alteration via implantation period in the nutrient content of the cereal grains and hydroponics fodder, the dry matter as well as non fiber carbohydrate values they, recorded significantly elevation in values of barley grain in comparative to sprouts, the crud protein, ash, ether extract, non protein, nitrogen true protein, neutral detergent fiber and sprouts were recorded significant higher value in comparative to grain. While, in organic matter and acid detergent fiber chemical analysis values were appeared non significantly. Such changes might be attributed to increase of the activity of grain hydrolytic enzymes lead to change chemical composition via germination, such conversion of the protein to essential amino acids, carbohydrates converted to simple sugars and

fats convert to essential fatty acids[19]. These alterations are in the same line noticed by some researchers[20-25]. The mean of moisture values are about 9.20±0.45 in grain contents, reach about 82.74±0.54 in sprouted barely contents due to plant absorbed a large amount of water via germination period on the other hand, It is quite interesting to note that the hydroponics forage production requires only about 3-5% of water needed to produce same amount of forage produced under field condition[2], but for producing 1 kg of maize fodder in hydroponic system about 1.50 L (if water is recycled) to 3.0 L (if water is not recycled and drained out) of water is required[26], thus such method of hydroponic forages production is very useful for fodder production in arid and semi arid areas.

Table 3 shows that there is clear elevation of blood serum parameters, in globulin, albumin, total serum proteins concentration and A/G ratio, which were recorded significantly ($p<0.05$) higher values in both treated groups in comparative with control group. This is in accordance with those reported by Kumar *et al*.[27] found a positive correlation between dietary protein and plasma protein concentration. The high level of globulin of sprouted barely treatments may indicate good developed immunity status by Ibrahim *et al*.[28], these results also is agreement with Chavan *et al*.[29] whom stated, the complex qualitative changes via soaking and sprouting of seeds which convert storage proteins of cereal grains into albumins and globulins caused the improvement of the quality of cereal proteins and increased the plant enzymes contents[30], through germination protease enzymes are activated and convert the protein polymers into amino acids and small peptides[31], these enzymes convert the complex compounds of protein into albumin and globulin which improve protein quality and elevate lysine content of grains[29], this might be explain the increased protein and albumin, globulin ratio in current study on the other hand, both treated groups appeared significant ($p<0.05$) higher values in creatinine as well as in urea values which might be reflect the higher metabolic rates due to activation of amylase and lipase enzymes via germination of seeds which increases sugar and essential fatty acids content of grains[32], that might be reflect the rising of urea and creatinine values in this study.

Table 3: Effect of substitution barley by 10 and 30% sprouted barley on some blood serum parameters in the diet of Awassi male lambs (Means±SE)

Items	Group (10%)	Group (30%)	Control group
Albumin (mg day^{-1})	3.54±0.32^{b}	4.14±0.13^{a}	3.23±0.08^{c}
Globulin (mg day^{-1})	3.21±0.28^{ab}	3.51±0.22^{a}	3.12±0.03^{c}
Total protein (mg day^{-1})	7.75±0.15^{a}	7.65±0.9^{a}	6.35±0.82^{b}
A/G ratio	1.16±0.06^{a}	1.17±0.02^{a}	1.03±0.32^{b}
Urea (mg day^{-1})	54.04±1.37^{b}	65.13±0.88^{a}	41.45±3.8^{c}
Creatinine (mg day^{-1})	1.24±0.36^{b}	1.51±0.12^{a}	0.77±0.32^{c}

$^{a-c}$Means with different superscripts in the same row are significantly different at $p<0.05$

Table 4 shows that there is an increase in body weight and the gain of body weight of all groups during the experimental period. Live weight gain depends on several factors such as breed characteristics, age, initial live weight, nutrition and management practice[33-35]. Lambs in the treated groups showed significantly ($p<0.05$) higher values in their average. Final body weight compared with the control group specially the 30% group which was reported significantly ($p<0.05$) higher value than those of 10% and control groups and total gain, besides their percentage compared with the control group. Many research trials have been conducted to assess the performance of livestock fed hydroponic green fodder[2]. Fayed[20] determined that addition of sprouted barley improved weight gain in lambs. This was in line with the concept of Naik *et al*.[26] coined out hydroponic sprouts are rich sources of bioactive enzymes and contain a grass juice ingredients that improves the performance of livestock. Tudor *et al*.[7] reported that an increase in weight gain of lambs received barley sprouts may attributed to enhancing of microbial activity in the rumen. Similarly a researcher also noticed that, the higher performance in the body weight gain of animals supplemented with 40% hydroponic fodder could be due to the ability of the supplements to supply necessary nutrients[23]. New Zealand Merino Co.[3] confirmed that fresh fodder of sprouted barley feed might be improved the performance by activation of enzymes during germination and transfer organic compound of grains to simpler forms, that arguments the suitability of this type of green fodder as a good livestock feed cause increase in appétit to taking

Table 4: Effect of substitution barley by 10 and 30% sprouted barley in the diet on total body weight and gain of Awassi male lambs (Means±SE)

Items	Group (10%)	Group (30%)	Control group
Initial average weight	20.75±0.13	20.66±0.31	20.58±0.21
Final average weight	31.83±0.43^{b}	36.68±0.11^{a}	28.66±0.25^{c}
Total body gain (kg)	11.08	16.02	8.08
Gain of initial weight (%)	53.39	77.54	39.26
Average daily gain (g)	92	133	67
Daily whole concentrate diet intake (2% b.wt. per head (g)	525	573	492
Feed conversation efficiency from whole diet (kg)	5.6	4.29	7.30

$^{a-c}$Means with different superscripts in the same row are significantly different at $p<0.05$

Table 5: Economical feasibility

Items	Group (10%)	Group (30%)	Control group
Average daily intake of concentrate diet as (2% b.wt. per head) (g)	525	573	492
Whole amount of concentrate diet consumed along experimental period (kg)	63.00	68.760	59.04
Concentrate diet (without sprouts) consumed along experimental period (kg)	60.48	60.48	59.04
Barley+sprouts in concentrate diet, daily per head (g)	210	229	196
Barley grain without sprouts, daily per head (g)	189	160	196
Only sprouts, (calculated as dry weight) daily per head (g)	21	69	-
Amount of sprout along experimental period per head (kg)	2.520	8.28	-
Sprouts coasts via experimental period about 100 and 125 of ID/1000 day^{-1} per head	12.000	14.400	-
Coast of whole concentrate without sprouts (0.6 ID/1000 kg per head)	36.28	36.28	35.45
Total body gain (kg)	11.08	16.02	8.08
The price of the gain in ID/1000 (12.000 kg^{-1} b.wt.$^{-1}$)	132.96	192.24	96.96
Total coast of the whole concentrate diet, sprouts include in ID/1000	48.28	50.28	35.45
Economical feed efficiency	84.68	141.96	61.51

sufficient amount of nutrition enable the lambs to increase in body weight[7,36]. Such normal concentrate diets easy to digest and make the rest feed diet more efficiently[2]. current study also with agreement with the studies those determined that feeding vitamins-rich green forage included, activate some enzymes during sprouting caused improvement in performance, digestive coefficient and animals growth rate[37,38]. In contrast of that, few study has declare that there is no significant effects on animal performance with the feeding hydroponic sprouts[39-41].

In Table 5 it was noticed that the mean of the amount of the total concentrate diet consumed for each animal were 63.00, 68.760 and 59.04 kg for groups 10 and 30% and control along the experimental period while, the amount of concentrate diet consumed by each animals without sprouts in were 60.48 ,60.48 and 59.04, respectively and total amount of sprouts treated groups were 2.520, 8.28 kg for 10 and 30% groups, respectively. However, the price of the concentrate diet without sprouts was approximately about 600 ID kg^{-1} while, the average coast of sprouts was 100, 125 ID kg^{-1} to each treated groups, respectively during all experimental period. Then, the total cost for the concentrate diet without sprouts for all groups were 36.28, 36.28 and 35.45 1/1000 of Iraqi Dinar. Thus, the cost of feeding was lower for the animals received 30% sprouted barley in their daily ration than those received 10% and control. This agreement results were displayed by Naik *et al.*[42] in sprouted maize fodder fed to desert goats and reported, environmentally friendly as well as reduced cost of feeding[43]. The assuming of the live weight price for each kilogram is approximately 12.000 Iraqi dinar and the total gain was 11.08, 16.02 and 8.08 kg for 10 and 30% and control groups, however, the average daily gains were improved with lambs fed hydroponic barley diet than lambs fed control diet, these findings also were in agreement with data showed by Hassan and Mona[44], Ata[45] and Fayed[20] whom used barley sprouts grown in rice straw to fed to growing Barki lambs and reported an increase in feed intake and gain of those lambs. Then, the total price are 132.96, 192.24 and 96.96 Iraqi Dinar/1000, thus, the total profit for each group were 84.68, 141.96 and 61.51 Iraqi Dinar/1000 for 10 and 30% and control group, respectively and this agree with results by Saidi and Omar[46] whom noticed there is a significant reduction in feed cost can be achieved when feeding rations incorporated with hydroponic fodder of sprouted barley.

CONCLUSION

In conclusion, of present study, feeding of substitutions of hydroponic barley fodder in diet of Awassi lambs in 10 and 30% increased total dry matter intake, decrease in feed conversion efficiency, increase total body weight gain and increase approximately in all blood serum parameters and economical profit particularly in 30%. According to these results, it could be recommend to substitution more high percent of barley by sprouted barley in the diet of ruminants than it had used in present study, for more economic profit and improvements of the productive traits, since more researches might be recommended in such direction particularly in desert and semi-desert areas.

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