Study and evaluation of feeding on Sprouted barley on the productive performance of dromedary camels

دراسة وتقييم التغذية بالشعير المنبت على الأداء الإنتاجي للإبل العربية

By

Fatma. R. Abdel Aziz

Camel Research Department, Animal Production Research Institute, Agricultural Research Centre, Egypt

Sherin ph. Mekhail

Barley Diseases Research Department, Plant Diseases Research Institute, Agricultural Research Center, Egypt

Doi: 10.21608/asajs.2024.366562

استلام البحث : ٢٢ / ٢ /٢٠٢٤

قبول النشـر : ١٥ / ٣ / ٢٠٢٤

Abdel Aziz, Fatma. R. & Mekhail, Sherin ph. (2024). Study and evaluation of feeding on Sprouted barley on the productive performance of dromedary camels. ***The Arab Journal of Agricultural Sciences***, Arab Institute for Education, Science and Arts, Egypt, 7 (23), 61 -90.

http://asajs.journals.ekb.eg

Study and evaluation of feeding on Sprouted barley on the productive performance of dromedary camels

Abstract :

The aim of the current research is to determine the practical level and nutritional properties of sprouted barley as a replacement for the traditional feed for fattening camels to investigate its efficacy of performance, nutritional value, digestibility, and fermentation characteristics in vivo and in vitro. The current research helps both workers and researchers to determine the level and the most effective way to utilize sprouted barley as an alternative strategy to traditional feeding systems., sprouted barley with traditional feed improves digestibility and fermentation characteristics. A total of 15 dromedary camels' males three years old Maghrebian camel's male in north coast were randomly assigned to three treatments (groups) of sprouted barley (0, 50, 75 %) diets., weight gain, Bodyweight, feed intake and feed efficiency were recorded every two weeks. Nutrient analysis was performed on feed, fecal, and urine samples. Dry m(DM) and non-fibrous carbohydrates were measured. Digestibility of DM, organic matter (OM), and neutral detergent fiber (NDF), as well as, pH value, ammonia-N, and volatile fatty acids (VFAs), were determined in vitro using continuous culture. Results showed that the treatments with sprouted barely increased crude protein (CP) content while neutral detergent fiber(NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) contents were decreased that final bodyweight was increased ($p < 0.05$), feed intake and the feed-to-gain ratio were increased ($p < 0.05$) in sprouted barley treatments. revealed a significant improvement on crude protein (CP) , ether extract (EE) , NDF and hemicellulose digestibility. The highest TDN% value was recorded by animals fed G3 (58.55%) followed by G2, G1 and the lowest value was for G1. Highest ($P \leq 0.01$) DCP% was 9.24% which recorded by G3 followed by G1, and G2, respectively. All animals were in positive N-balance but animals fed on G1 retained the least amount of nitrogen balance (mg/kg BW) among treatments. Nutrient analysis indicators of sprouted barley treatments (50 to75 %) were higher ($p < 0.05$) for DM, crude protein, acid detergent fiber, lignin and ash, and higher for total digestible nutrients, NDF, fat, phosphorus, zinc, copper, and net energy than the traditional diet. In the in vivo study, the digestibility of nutrients in sprouted barley treatments was improved ($p < 0.05$), while the diet (sprouted barley control 0%) had the lowest digestibility of DM, OM, and NDF compared with the other treatments in the in vitro study. In conclusion, the addition of sprouted barley improved digestibility, and fermentation characteristics, having a positive effect on growth.

Keywords:
Dromedary camels, nutrient digestibility, rumen fermentation,sprouted barley

المستخلص:

الهدف من البحث الحالي هو تحديد المستوى العملي والخصائص الغذائية للشعير المستنبت كبديل للأعلاف التقليدية لتسمين الإبل للتحقق من كفاءته من حيث الأداء والقيمة الغذائية والهضم وخصائص التخمير في الجسم الحي وفي المختبر. يساعد البحث الحالي كلاً من العمال والباحثين على تحديد المستوى والطريقة الأكثر فعالية لاستخدام الشعير المستنبت كاستراتيجية بديلة لأنظمة التغذية التقليدية. يعمل الشعير المستنبت مع الأعلاف التقليدية على

ISSN: 2537-0804 eISSN: 2537- 0855

تحسين خصائص الهضم والتخمير. تم توزيع إجمالي ١٥ من ذكور الإبل العربية البالغة من العمر ثلاث سنوات في الساحل الشمالي بشكل عشوائي على ثلاث (مجموعات) من الشعير المستنبت (٠، ٥٠، ٧٥٪) على العلائق، وزيادة الوزن، ووزن الجسم، وتناول العلف، وكفاءة التغذية. تم تسجيلها كل اسبوعين تم إجراء تحليل المغذيات و عينات الأعلاف والبراز والبول. تم قياس المادة الجافة والكربوهيدرات غير الليفية. تم تحديد قابلية هضم المادة الجافة ، والمواد العضوية (OM)، وألياف (CF)، وكذلك قيمة الرقم الهيدروجيني، والأمونيا-N، والأحماض الدهنية المتطايرة (VFAs)، في المختبر. أظهرت النتائج أن المعاملة الثالثة ادت الى زيادة البروتين المهضوم بينما انخفضت مNDF وADF وADL(الليجنوسيليلوز) مما أدى إلى زيادة وزن الجسم النهائي (P <٠.٠٥)، وزاد تناول العلف ونسبة التغذية إلى الكسب (P <٠.٠٥) استبدال الشعير. كشفت عن تحسن كبير في البروتين الخام ، وقياس معدل الدهون EE، NDF وهضم الهيمسيلولوز. تم تسجيل أعلى قيمة المركبات الكلية المهضومة TDN% في الحيوانات التي تم تغذيتها على G3 (58.55%) تليها G2، G1 وأقل قيمة كانت لـ G1. أعلى نسبة (P<٠.٠١) DCP كانت ٩.٢٤% والتي سجلتها G3 تليها G1 وG2 على التوالي. كانت جميع الحيوانات ذات توازن N إيجابي ولكن الحيوانات التي تم تغذيتها على G1 احتفظت بأقل قدر من توازن النيتروجين (ملجم / كجم من وزن الجسم) بين المعاملات. كانت مؤشرات تحليل المغذيات لمعاملات الشعير المستنبت (٥٠ إلى ٧٥٪) أعلى (P <٠.٠٥) بالنسبة للدم والبروتين الخام وألياف المنظفات الحمضية واللجنين والرماد، وأعلى بالنسبة لإجمالي العناصر الغذائية القابلة للهضم، NDF، والدهون، والفوسفور، والزنك، والنحاس، والطاقة الصافية من النظام الغذائي التقليدي. في الدراسة التي أجريت على الجسم الحي، تحسنت قابلية هضم العناصر الغذائية في علاجات الشعير المستنبت (P <٠.٠٥)، في حين أن النظام الغذائي (التحكم في الشعير المستنبت بنسبة ٠%) كان له أدنى معدل هضم لـ DM وOM وNDF مقارنة بالمعالجات الأخرى في المجموعة. في الدراسة المختبرية. نستنتج من ذلك أن إضافة الشعير المستنبت أدى إلى تحسين خصائص الهضم والتخمر، مما كان له تأثير إيجابي على النمو.

ISSN: 2537-0804 eISSN: 2537- 0855

1. INTRODUCTION

Camels are an important resource that support food security in many countries, which are mostly raised on extensive grazing systems., which depend mainly on climatic variations, including temperature and precipitation, also seasonal (**Ata, .2016)**. The shortage of animal feeds in Egypt necessitates that intense research efforts should be directed towards exploring the possibility of using new-non conventional sources or agricultural by-products as animal feed and improving their nutritive values **(Shoukry *et al.*,2013)** cereal crops generate large amount of organic agricultural waste in many countries The use of hydroponic in producing green fodder under Egyptian condition take more attention in the last few years to cover the fodder gab especially under the population increment, food security demands and climate change impacts. The high Egyptian population creates high pressure under the current condition of water scarcity and expected impacts of climate change on agriculture system. Many different types of small grains such as wheat, oats, corn and legumes can be used in hydroponic systems, barley is the most common. Barley is an important raw material for feed industry and widely used for animal feeding as grain in livestock (whole grain, the form of cracked or pomade, particularly in the breeding season) also green fodder (the fiber content increased from 3.75% in un-sprouted barley seed to 6% in 5-day sprouts. **(Peer and Leeson., 1985b)** found significant losses in dry matter digestibility, which declined progressively during 7 to 8-day growing period nevertheless the digestibility of 4-day old sprouts barley was superior to original grain in vitro

ISSN: 2537-0804 eISSN: 2537- 0855

digestibility of sprouts grown at 6 or 8 days ranged 72-74 percent that were not significantly different Otherwise, that will be led to depend more on soilless culture system in agriculture production for increasing the water, fertilizers and area use efficiencies to meet the high demand of food production. Agriculture was the most critical sector under the global climate change impacts. Natural water resources are affected by global climate change so food production and sustainability are endangered. It’s expected that the global climate change cause negative impact on the grazing lands in the arid and semi-arid regions, the rainfall is reduced while environmental temperature is increased, so the grassland yields decrease and range and meadow deteriorated over the time. The concept of putting one kilogram of grain into a hydroponic system and producing 6 to 10 kilograms of fresh green sprouts, independent of weather and at any time of year, is of interest. Due to the lack of rangeland fodder, Producers, herders and breeders compelled to switch to alternative feed sources ,the result, their production patterns have shifted to semi-intensive systems using traditional feeds such as grain and rough fodder However, the nutrient requirements of grazing animals are not often met under such systems to allow them to reach their productive efficiency **(Hafla, *et al.*, 2014)** including high prices globally and waste from water source consumption **(Fayed, 2011).** Sprouted barley is a new way of producing feed forages without using soil, with a high germination rate and a fast-growing period. This method could be especially important in regions where water shortages and the seasonality of forages are common

ISSN: 2537-0804 eISSN: 2537- 0855

challenges for livestock producers **(Saidi, *et al.*, 2015).** Sprouted grains are efficiently digested compared to grain seeds because of the high activation of hydrolytic enzymes as a result of germination **(Lemmens, .*et al.*, 2019)**. Consequently, **(Fazaeli *et al.*,2012)** reported that hydrolytic enzymes convert proteins, starch and fat into simple forms of amino acids, sugars, and fatty acids. Furthermore, the sprouted process increases the content of crude fiber **(Girma, *et al.*,2018)**, chelates of minerals (**Shipard, 2005)**, and decreases the content of phytic acid and protease inhibitors, as well as many other anti-nutrients **(Farghaly.*et al.*,2019)**. In addition, the important benefit of producing sprouted barley is the minimal water consumption compared to the conventional production system. Germination has been demonstrated to be an inexpensive (low-cost process) and sustainable process that improves nutrient quality and the content of functional compounds of grains, as well as their palatability, digestibility, and bioavailability **(Cáceres, *et al.*,2014)** and **(Cáceres, *et al.*,2017)**. However, the magnitude of changes caused by germination depends on the grain variety and germination conditions **(Rico, *et al.*,2020)**.Several studies suggest that feeding sprouted barley increases performance only in animals that do not receive adequate protein, energy, or minerals **(Sneath, *et al* 2003)**, or that the readily available nutrients in sprouted barley may stimulate enhanced utilization of poor-quality feed **(Tudor, *et al.*,2003)** .

The aim of this study is that sprouted barley could be an alternative strategy to traditional feed for fattening camels, with the identification of factors resulting from the

ISSN: 2537-0804 **eISSN: 2537- 0855**

substitution of animals. the main objective of the current study is to investigate the effects of freshly sprouted barley levels with traditional feed on growth performance, nutritional value, and digestibility in fattening camels Additionally, to evaluate sprouted barley levels with traditional feed (DM basis) on digestibility, and fermentation characteristics in vitro using a continuous culture fermentation.

2. Materials and Methods

The trial was carried out at private farm in North coast in closed farm Khamis farm village, in Matrouh Province, Egypt.

2.1. Sprouted Barley Production

Barely (Hordeum vulgare L.) cv. cultivars were evaluated in this study: Giza 128. The cultivars seeds were soaked in water separately; with the purpose of eliminate the float materials (straw, wastes and etc.). Then barely seeds were soaked in warm water (40 o C) containing 0.1% Sodium hypochlorite (5%) for 30 minutes then washed by tap water for 10 minutes. Planting trays also were cleaned and disinfected by using 0.1% Sodium hypochlorite (5%) later on washed by tap water to remove any chemical traces. The intensive hydroponic system constructed by using a steel stand, size 2.10 m X 0.50 m X 1.9 m (L X W X H) equipped containing 6 shelves (30 cm apart shelves) with capacity of 42 polyethylene trays sized 60×30x3 cm (0.18 m2) 1.8 Kg/tray each (equivalent to about 10 kg/m2) according to the results obtained by **(Baker, *et al.*, 2002).**

The hydroponic unit located under white net house during the studied periods for protecting the system, seeds and sprout. The irrigation of shelves from water tank. Black polyethylene tank 1 m3 was used as water tank. The base of trays was holed to allow drainage of excess water of irrigation. The used water was tap water with free nutrient solution or any additives. The leaching water collected and determined to calculate water consumption.

2.2. Sprout Yield characteristics

At the end of experiment (8 days after seeding), the produced barely sprouts (green fodder) was ready for harvesting. Barely shoots and root mats (sprouts) in the trays of cultivars were harvested and the following data were recorded: total fresh and dry sprouts yield (Kg/m2). Shoot height (cm), and conversion factor (ratio of produced barely sprouts to the initial planted seed weight (Kg/Kg).

Table 1 : The average quality characteristics of barley's sprout

Cultivar	Nitrogen %	Protein %	Crude fat %	Ash %	Fiber %
Barley Giza 128	1.71 ab	9.88a	3.87	2.85	11.1

* Similar letters indicate non-significant at 0.05 levels.

2.3. Feeding trial

Fifteen dromedaries' camel's male with an average body weight of 275.34±310.29 kg (2 to 3 years of age) were randomly divided into three equal groups (5 animals each). The experiment was lasted 120 days in which camels were feeding one of the next dietary treatments as follow:

G1: Alfalfa (Medicago sativa) ad libitum (control).

G2: sprouted barley grains on 50%.

G3: sprouted barley grains on 75%.

ISSN: 2537-0804 eISSN: 2537- 0855

A feeding experiment followed by a metabolism trial was conducted**.**

2.4. Diets Sampling and Analysis

During the study period, every 15 days of the study (five replicates), feed samples were collected in the same levels of sprouted barley given to the treated lambs, dried (60 °C) to determine the initial moisture content and then ground to a fine powder. According to the previously described method **(Hafla, *et al.*,2014)** the forage powder samples were analyzed in triplicate to estimate the content of nutrients such as dry matter (DM) by drying overnight at 105 °C in a drying oven (Sanyo convection oven, Osaka, Japan), crude protein (CP; Kjeldahl method, using an N conversion factor of 6.6), crude fat, ash, total digestible nutrients (TDN), and net energy (NE) according to the methods of the Association of Official Analytical Chemists **(AOAC .,2012)**. According to **(Van Soest, *et al* 1991)** fiber fractions such as neutral detergent fiber (NDF), acid detergent fiber (ADF), and lignin were determined. Organic matter (OM) was calculated as OM % = 100-ash **(Haddad, and Younis, 2004)**. Non-fibrous carbohydrates (NFC) were calculated using the equation NFC (%) = 100% − (CP + total fiber + crude fat + ash) according to **(Bachmann, *et al.*,2019)**. The content of macro and micro minerals such as calcium, phosphorus, magnesium, potassium, sulfur, sodium, zinc, and copper were digested in a mixture of sulfuric acid and hydrogen peroxide (105 °C) in a closed microwave using the method previously described **(Kaur, *et al.*, 2019)** , **(Fazaeli, *et al* ., 2012)**. All minerals were determined by an atomic absorption spectrometer

ISSN: 2537-0804 eISSN: 2537- 0855

(PerkinElmer, instruments, Analyst, Waltham, MA, USA) using the Association of Official Analytical Chemists **(AOAC.,2012).**

2.5. Housing camels and Experimental Design

A total of 15 dromedaries camel male were used for the present study for 75 days. They were purchased at the age of 3 months from local trust worthy farms, and then brought to the Experimental. camels were weighed individually and then randomly divided into 3 individual pens in five feeding treatments, each pen representing one experimental unit (nine replicates per treatment with one camel per replicate), based on a completely randomized design under the natural winter environmental conditions of the region. Feed treatments were distributed as follows: T1: 100% added traditional feed (control; 70% barley grain + 30% alfalfa hay), T2: 50% added barley sprouts with 75% traditional feed, T3:75% added barley sprouts with 25% traditional feed. all camels were acclimatized to the used diet for 14 days, vaccinated against enterotoxaemia and septicemia, and PPR subcutaneously inoculated with an agent against recto- parasite. During the study period, all animals were provided ad libitum access to feed and water, as well as up to 5% additional feed daily to reach refusal.

2.6. Chemical analysis:

The dry matter (DM) and crude protein (CP) were determined according to (**A.O.A.C., 1997)**. The neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to **(Goering,. and Van Soest ,1970)**. Rumen total volatile fatty acids (TVFA's) were (Warner, 1964) and ammonia nitrogen

ISSN: 2537-0804 eISSN: 2537- 0855

values were also evaluated. Sodium (Na) and potassium (K) were determined by using the standard flame photometer **(Jackson., 1958)**. Blood serum samples were assayed for total protein **(Armstrong and Carr, 1964)** and albumin **(Doumas *et al.*, 1971)**, while globulin was calculated by the difference between. Serum creatinine **(Henry, 1965)** and urea **(Patton and Crouch, 1977)** were also determined. All blood serum analysis were estimated using Jenway spectrophotometer (UK).

2.7. Statistical analysis:

The general linear models **(SAS, 1998)** was analyzed of collected data. The used design was one way analysis of variance and differences between mean values were compared by **(Duncan, 1955)**

3.RESULTS AND DISCUSION

3.1. The vegetative characteristics of barley cultivar:

The average daily increasing ratio of fresh barely sprouts weight during the growing period. The average daily increasing ratio of fresh sprouts weight in general increased about 1.55 times their original pre-steeped weight after first day, 1.18 times after second day, 1.19 times after third day, 1.18 times after fourth day, 1.28 times after the fifth day then the incremental ratio start to go down to record 1.22 times after the sixth day and 1.09 times after seventh day. According to **(Peer and Leeson, 1985b**) fresh weight increased from 1.72 times of the original seed weight, after the first day of sprouting, the white tip of the radical is visible. By the third day, the radical has branched and the blade inside the heath has turned green. After the fourth day

ISSN: 2537-0804 eISSN: 2537- 0855

of seedling, a green blade has protruded above the sheath and the roots of the kernels have formed a definite mat with other kernels. From the first to the eighth day, the main visible change is the increase in root length and thickness.

Table 2: The production of barley cultivars in hydroponic system (Kg/m2) during the growing period.

The weight of barley sprouts (Kg/m2)										
Days after sowing										
Cultivar	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**	**Day 8**	**SEM**	**P-Value**
Giza 128	10	17.2a	20.7a	25.8a	35.3b	47.3b	63.4b	61.4b	0.643	0.091

** Similar letters in each column indicate non-significant at 0.05 levels.*

3.2. Chemical composition of the tested rations:

The chemical compositions of different tested feeds are shown in Table 2. Sprouted barley grains on 75% (T3) showed higher contents of CP, EE, sodium and potassium compared to T1, T2. On the other hand, the lowest values of CP, EE, GE, sodium and potassium were recorded by T2, while alfalfa (T1) had the highest values of CP, NFE, GE, sodium and potassium compared with the four treatments this data matching with **(Mahmoud, and El-Anany,2014).**The improvement in sprouted mixtures may be attributed to increase the activity of sprouted barley seed hydrolytic enzymes which catabolized starch to soluble sugars for use in respiration and cell-wall synthesis during the germination and early stage of plant growing and lead to improvements in chemical composition of sprouted barley .

ISSN: 2537-0804 eISSN: 2537- 0855

Table (3): Chemical composition of the experimental diets.

Item	Experimental diet				
	T1	**T2**	**T3**	**SEM**	***P*-Value**
Organic matter (OM)	83.79	84.64	85.92	0.061	0.356
Crude protein (CP)	13.90	9.97	10.76	0.003	0.124
Crude fat (CF)	2.51	3.20	3.95	0.008	0.216
Nitrogen free extract (NFE)	42.88	40.86	43.31	0.076	0.005
Neutral detergent fiber (NDF)	45.00	68.42	70.09	0.104	0.021
Acid detergent fiber (ADF)	32.00	41.40	44.74	0.521	0.076
Acid detergent lignin (ADL)	10.33	16.43	17.43	0.089	0.082
Cellulose	21.67	24.97	25.31	0.043	0.043
Hemicellulose	13.00	27.02	26.35	0.112	0.231
GE Mcal/kg DM1	381.68	374.70	375.55	1.054	0.00
Sodium	0.430	0.186	0.196	0.002	0.00
Potassium	0.606	0.156	0.166	0.004	0.01

T1: Alfalfa (Medicago sativa) (control), T2: sprouted barley fodders on 50%, T3: sprouted barley fodders on 75% . GE (Mcal/kg DM) =CP×5.65+CF×4.15+EE×9.40+NFE×4.15 Blaxter (1968)

3.3. Effect of dietary treatments on growth performance

Apparent total tract digestibility in dromedary male camels during the study period. The effects of dietary treatments on growth performance and apparent total tract digestibility of the dromedary male camels are shown in Table 3. The results of the study show that the partial replacement of sprouted barley (T2 to T3) had positive effect on LWG, while dromedary male camels fed 0% sprouted barley (T1) had a lower LWG compared to the traditional diet ($p < 0.05$). DMI and OMI were higher at T2 and T3 compared to T1 and ($p < 0.05$). Apparent total tract digestibility of DM and OM was increased in dietary treatments from T2 to T3 compared , while there was significant difference between T1 and ($p < 0.05$). Moreover, a linear response of IBW,

ISSN: 2537-0804 eISSN: 2537- 0855

FBW, BWG.ADG, and apparent total tract was observed with the replacement of sprouted barley ($p < 0.05$). In the feeding trial, animals were group fed so it was possible to test differences in feed efficiency; however, it is interesting to note that all three groups receiving sprouted barley (Table 3) showed slightly better feed conversion ratios, **(Gebremedhin, 2015)**

Results of the 140-day trial show significant differences in liveweight gain between camels receiving sprouted 75%. Feed consumption and efficiency of gain were comparable for the different treatments.

Table (4): Growth performance for dromedary male camels fed on dietary treatments with different levels of sprouted barley

ITEM	T1	T2	T3	SEM	*P*-Value
IBW (kg)	230.54	234.21	233.56	0.91	0.923
FBW (kg)	389.4 ^{a}	391.2 ^{b}	402.1 ^{b}	1.88	0.857
BWG (kg)	13.18 ^{a}	10.60 ^{a}	10.50 ^{a}	1.46	0.877
ADG (g/d)	600.8 ^{a}	721.6 ^{a}	760.5 ^{a}	19.5	0.436
ADI (g/d)	1117 ^{d}	1338 ^{c}	1587 ^{b}	63.1	0.590
FI: WG (g:g)	7.2 ^{c}	10.2 ^{c}	11.8 ^{bc}	2.15	0.051
RG %	41.5 ^{a}	31.6 ^{a}	32.3 ^{a}	3.29	0.052

[a–d] Means values within rows for each item with clarification of the significant difference in the form of superscripts ($p < 0.05$). [1] Treatments, T1: 100 % traditional diet (Barley 70: Alfalfa hay 30); T2: 50% traditional diet with 50% sprouted barley; T3: 25% traditional diet with 75% sprouted barley; [2] IBW = Initial body weight; FBW = Final body weight; BWG = Weight gain; ADG = Average daily gain; ADI = Average daily intake (g/d); FI: WG = Feed-to-gain ratio; RG = Relative growth. [3] SEM = Standard error of means for treatments effect.

ISSN: 2537-0804 eISSN: 2537- 0855

3.4. Feed digestibility

The data from the digestion trial (Table 5) represent individual and average coefficients of digestion for a 10-day collection period. average digestion coefficients for all nutrients were slightly higher for the sprouted barely diet (Table 5) shown that treated groups specially 75% sprouts supplementation group recorded higher significantly (<0.05) values in Dry matter digestibility, Organic matter digestibility, Crude protein digestibility and Ether extract, digestibility respectively than 10% sprouts supplementation group and control group respectively ,except in Crude fiber digestibility in which treated groups particularly control group , recorded significantly (<0.05) the lowest values compared to treated T1 group which were was recorded the lowest value.

Table (5): Digestibility (%) apparent for dromedary male camels fed on dietary treatments with different levels of sprouted barley

Item	Treatments				
	T1	T2	T3	SEM	*P*-Value
DMD, %	81.80 ^{b}	81.59 ^{b}	87.33 ^{a}	1.69	0.234
OMD, %	82.73 ^{b}	82.47 ^{b}	88.34 ^{a}	1.63	0.653
CPD, %	72.41 ^{b}	69.61 ^{b}	79.19 ^{a}	3.46	0.044
NDF, %	65.31 ^{c}	67.51 ^{bc}	74.49 ^{bc}	3.84	0.012
ADF, %	67.96 ^{bc}	66.38 ^{c}	73.03 ^{bc}	2.46	0.002
Lignin, %	72.40	74.42	80.17	3.33	0.127
NFC, %	99.54	98.79	99.26	0.63	0.001
Fat, %	65.21 ^{c}	61.04 ^{c}	73.92 ^{b}	5.95	0.061
Ash, %	64.93	64.56	66.71	3.80	0.725
Calcium, %	40.58	42.03	43.86	7.57	0.581
Phosphorus, %	47.85	57.03	55.34	5.35	0.754
Magnesium, %	39.91 ^{b}	41.84 ^{b}	58.50 ^{a}	4.65	0.967
Sulfur, %	65.83 ^{b}	65.90 ^{b}	76.15 ^{ab}	3.27	0.874
Sodium, %	72.97	75.32	82.08	5.22	0.341

ISSN: 2537-0804 eISSN: 2537- 0855

a–c Means values within rows for each item with clarification of the significant difference in the form of superscripts ($p < 0.05$). 1 Treatments, T1: 100 % traditional diet (Barley 70: Alfalfa hay 30); T2: 50% traditional diet with 50% sprouted barley; T3:25% traditional diet with 75% sprouted barley. 2 DM = Dry matter; OM = Organic matter; CP = Crude protein; NDF = Neutral detergent fiber; ADF = Acid detergent fiber; NFC = Non-fibrous carbohydrates. 3 SEM = Standard error of means for treatments effect. significant(<0.05) higher values in most contents of feed digestibility , in the crud fiber digestibility in which treated groups particularly 75% and 50% supplementation respectively recorded the lowest value , however this results were mostly agree with (Laredo *et.al.,(*27) who reported in study that addition of sprouted barley increased Dry Matter, Organic Matter, Crud Protein , Ether Extracts , and Crud Fibers, digestibility, this might be due to high content of leafy and roots portions contents of sprouts which is easy to digest and hydrolysis by the enzymes of rumen microflora, as well as enzymatic digestion(proteases) present in the lytic vacuoles of plant cells . **(Kingston *et.al.,*2005 and *Feller,*1986*)*** also were confirmed that these enzymes are commence initial degradation of protein in the rumen in few hours of forage ingestion. Similarly (**Shipard, 2005)** observed there is an increase in nutrient digestibility by the addition of sprouted grains in the diet of ruminants. (**Peer, and Leeson, 1985b**), as well as , (**Morgan, *et al.,* 1992),** were reported that OM and DM digestibility were in maximum by the addition of old sprouted barely., this study also in fully occurrences with (**Moghaddam, *et al.,*2009)**

ISSN: 2537-0804 **eISSN: 2537- 0855**

who determine the effect of sprouts on nutrient digestibility at the level of 0, 33, 66 and 100%, , nutrient digestibility was increased by increasing the level of sprouted barley and was confirmed that the 100% replacement resulted in better nutrient digestibility as compared to other levels. In Contrary to these progress (**Dung, ,2010), (Sneath, and McIntosh, 2003)** were revealed that there were non-significant effect of sprouted grains on nutrient digestibility, on the other hand other researchers observed that there is a relationship between particle size of sprouts feed composition which were facilitate forming microbial colonies in the rumen and accelerate feed digestibility and passage rate (**Ehle, , 1984)**, (**Laredo, and Mison ,1975a)**. In addition , surface area for microbial attachment and subsequent degradation have another aspect of digestibility that make ruminants favors the leaf portion above the stem of sprouts, especially in camels which, consumed more tropical grass leaves than stem **(Popp , *et.al.*,1981***)*. Current study ,in good a agreement with (**Nutrgrass ,2007)** ,who declare that the roots comprised of interwoven mass with the seeds husk which housed the endosperm at seeds formation, the husk of seeds has high in fiber that made up of cell wall polysaccharides such as cellulose and hemi-cellulose that are usually more resistant to digestion than leave, This explains the decline in the value of crud fiber digestibility in both of 10%and 30% treated groups compared to control group.

ISSN: 2537-0804 **eISSN: 2537- 0855**

3.5. Ruminal fermentation parameters

Rumen pH, total volatile fatty acids (TVFA, s), ammonia-nitrogen and total CO_2 gas production are presented in Table 6. It was clear that camels fed T3 recorded the highest significant pH value compared to the other experimental groups. The highest value of pH was obtained before feeding compared to time of post feeding. One of the most important factors influencing rumen pH is the amount of saliva buffer secretion, which is positively correlated with rumination activity (**Lu et al. 2005).** Moreover, (**Van Soest.,1994)** reported that cellulolytic organisms grow optimally at pH 6.7 and pH below 6.2 inhibited the rate of digestion, decreased acetic acid and depressed cellulolytic activity. Rumen total volatile fatty acids (TVFA, s) revealed that supplemented sprouted media with 3% urea increased ($P \leq 0.01$) TVFA, s concentrations in the rumen, which increased after feeding and reaches its peak after 3 hours post feeding (11.74meq/100ml). Animals fed on T5 recorded the highest value of total volatile fatty acids concentrations; it might be a reflection to rich energy and organic matter of fodder fed to small ruminants that provided higher concentrations of rumen metabolites which naturally improved rumen function and digestibility **(Bonsi *et al.*, 1995).** The increase in TVFA, s concentration in animals fed sprouted barley may be due to that sprouts provide a good supply of vitamins, enzymes which serve as

ISSN: 2537-0804 eISSN: 2537- 0855

bioactive catalysts to assist in metabolism of feed and the release of energy **(Shipard, 2005)**. In addition, **(Opera *et al.*,1975)** reported that N supplementation from urea could increase the activity of rumen microbes in degrading carbohydrates (cellulose and starch) for TVFA, s production when the energy level was sufficient. These results were in accordance with those obtained by **(Abd EL-Nabi.,2007)** and **(Helal.,2012)** who reported that dietary sprouted barley mixture increase TVFA, s in sheep rumen. Camels fed T3 recorded the highest ($P \leq 0.01$) ammonia-nitrogen compared with other experimental groups. The highest values of ammonia-nitrogen were 40.79 mg/100ml post feeding with 3 hours. This is may be due to its high content of CP and highest CP intake for animals fed this group **(Norton, 2003).** Other researchers reported an increase in rumen ammonia N with increase in CP supplementation **(Bohnert *et al.*, 2002 and Salisbury *et al.*, 2004)**. Moreover, **(Highstreet *et al.*,2010)** reported that higher ruminal NH3-N concentration occurred when steers were fed urea treated rice straw because of the relatively high levels of soluble CP which would likely have caused higher rumen ammonia levels particularly immediately after feeding**.**

ISSN: 2537-0804 eISSN: 2537- 0855

Table (6). The pH value, Ammonia-N and CO_2 gas production during the in vitro digestion and fermentation for dietary treatments with different levels of sprouted barley for dromedary male camels

ITEM	Treatments					
PH	**T1**	**T2**	**T3**	**SEM**	**Sig.**	**P-Value**
0	6.78a	6.55b	6.64ab	0.064	*	**0.022**
3	6.01d	6.09c	6.13c	0.018	**	**0.031**
6	6.40	6.22	6.27	0.056	**ns**	**0.120**
TVFA, s						
0	5.53	4.78	5.10	0.520	**ns**	**0241**
3	10.12bc	8.89c	9.18bc	0.485	**	**0.042**
6	8.62b	6.98c	7.84bc	0.329	**	**0.053**
NH3-N						
0	22.40c	22.90bc	25.64ab	0.921	**	**0.011**
3	39.77b	36.03d	38.09c	0.281	**	**0.031**
6	34.10b	31.78c	32.70c	0.321	**	**0.048**
TGP, mL	179.3 ^{b}	176.1 ^{b}	185.4 ^{b}	3.13	**	**0.022**

[a,b] Means values within rows for each item with clarification of the significant difference in the form of superscripts ($p <$ 0.05). [1] Treatments, T1: 100 % traditional diet (Barley 70: Alfalfa hay 30); T2: 50% traditional diet with 50% sprouted barley; T3: 25% traditional diet with 75% sprouted barley;. [2] NH3 = Ammonia-N; TGP = total CO_2 gas production. Total VFA = total volatile fatty acids [3] SEM = Standard error of means for treatments effect.

4. Conclusions

In summary, From the results of the present study, replacing traditional feed with sprouted barley improved digestibility, rumen fermentation and increased the concentration of some VFAs and rumen bacteria, resulted in an increase in DMI and OMI, which positively affected live

ISSN: 2537-0804 eISSN: 2537- 0855

weight gain. However, it should be noted that sprouted barley should be used as the feed for camels due to its very high content DM. Further studies are advisable to achieve optimal performance.

ISSN: 2537-0804 eISSN: 2537- 0855

References

A.O.A.C. (1997). Official Methods of Analysis. 16th Ed. Assoc. Office. Anal. Chem., Arlington, VA.

Abd El-Nabi, Haiam E. (2007). Using sprouted barley and fenugreek on rice straw to replace berseem hay in growing lamb rations. MSc. Thesis, Fac. of Agri Cairo University, Egypt.

AOAC. *Official Methods of Analysis*, 19th ed.; Association of Official Analytical Chemists: Rockville, MD, USA, 2012. [Google Scholar]

Armstrong, W.D. and C.W. Carr (1964). Physiological chemistry. Laboratory Direction, 3 rd ed., P. 75, Burges bublishing Co. Minneapolis, Minnestota. Artificially grown barley fodder by Sheep. Indian J. Small Rumen, 4 (2): 63-68.

Ata, M.(2016) Effect of hydroponic barley fodder on Awassi lamb's performance. *J. Biol. Agric. Healthc.* 2016, *6*, 60–64. [Google Scholar]

Bachmann, M.; Kuhnitzsch, C.; Okon, P.; Martens, S.D.; Greef, J.M.; Steinhöfel, O.; Zeyner, A. Ruminal in vitro protein degradation and apparent digestibility of energy and nutrients in sheep fed native or ensiled+ toasted pea (*Pisum sativum*) grains. *Animals* 2019, *9*, 401. [Google Scholar] [CrossRef] [PubMed][Green Version]

ISSN: 2537-0804 eISSN: 2537- 0855

Baker, J. F., Vann, R. C. and Neville, W. E. Jr. 2002. Evaluations of Genotype Environment Interactions of Beef Bulls' Performance Tested in Feedlot or Pasture. J. Anim. Sci., 80(7): 1716-1724.

Bohnert, D.W.; C.S. Schauer; S.J. Falck and T. DelCurto (2002). Influence of rumen protein degradability and supplementation frequency on steers consuming low-quality forage: I. Ruminal fermentation characteristics. J. Anim. Sci., 80: 2978-2988.

Bonsi, M.L.K.; P.O. Osuji and A.K. Thuah (1995). Effect of supplementing tef straw with different level of leucaena or sasbania on the degradability of tef straw, sesbania, leucaena, tagaste and vernonia and certain rumen and blood metabolites in Ethopianmenz sheep. Anim. Feed Sci Technol 52: 101-129.

Cáceres, P.J.; Martínez-Villaluenga, C.; Amigo, L.; Frias, J. Maximising the phytochemical content and antioxidant activity of Ecuadorian brown rice sprouts through optimal germination conditions. *Food Chem.* 2014, *152*, 407–414. [Google Scholar] [CrossRef][Green Version]

Cáceres, P.J.; Peñas, E.; Martinez-Villaluenga, C.; Amigo, L.; Frias, J. Enhancement of biologically active compounds in germinated brown rice and the effect of sun-drying. *J. Cereal Sci.* 2017, *73*, 1–9. [Google Scholar] [CrossRef][Green Version]

ISSN: 2537-0804 eISSN: 2537- 0855

Doumas, B.; W. Wabson and H. Biggs (1971). Albumin standards and measurement of serum with bromocresol green. Clin, Chem., Acta.

Duncan, D.B. (1955). Multiple ranges and multiple. F. Tests Biometrics. 11: 1-42.

Ehle, F.R., 1984.influence of feed particle density on particulate passage from rumen of holstin cow .J.Dairv Sci., 67:693-697.

Farghaly, M.M.; Abdullah, M.A.; Youssef, I.M.; Abdel-Rahim, I.R.; Abouelezz, K. Effect of feeding hydroponic barley sprouts to sheep on feed intake, nutrient digestibility, nitrogen retention, rumen fermentation and ruminal enzymes activity. *Livest. Sci.* 2019, *228*, 31–37. [Google Scholar] [CrossRef]

Fayed, M. Afaf (2011). Comparative study and feed evaluation of sprouted barley grains on rice straw versus Tamarix Mannifera on performance of growing barki lambs in Sinai Journal of American Science, 7 (1): 954-961.

Fazaeli, H.; Golmohammadi, H.A.; Shoayee, A.A.; Montajebi, N.; Mosharraf, S.H. Performance of feedlot calves fed hydroponics fodder barley. *J. Agric. Sci. Technol.* 2011, *13*, 365–375. [Google Scholar]

Feller, U., 1986.Plant Proteolytic Enzymes in Relation to leaf Senescence In:CRC Press ,Boca Raton f.L., USA., pp:49-68.

ISSN: 2537-0804 eISSN: 2537- 0855

Gebremedhin, W. Nutritional benefit and economic value of feeding hydroponically grown maize and barley fodder for Konkan Kanyal goats. *J. Agric. Vet. Sci.* 2015, *8*, 24–30. [Google Scholar]

Girma, F.; Gebremariam, B. Review on hydroponic feed value to livestock production. *J. Sci. Innov. Res.* 2018, *7*, 106–109. [Google Scholar]

Goering, H.K. and P.J. Van Soest (1970). Forage fiber analysis. Agricultural Handbook, No. 379, USDA, Washington. DC, USA.

Haddad, S.G.; Younis, H.M. The effect of adding ruminally protected fat in fattening diets on nutrient intake, digestibility and growth performance of Awassi lambs. *Anim. Feed Sci. Technol.* 2004, *113*, 61–69. [Google Scholar] [CrossRef]

Hafla, A.N.; Soder, K.J.; Brito, A.F.; Rubano, M.D.; Dell, C.J. Effect of sprouted barley grain supplementation of an herbage-based or haylage-based diet on ruminal fermentation and methane output in continuous culture. *J. Dairy Sci.* 2014, *97*, 7856–7869. [Google Scholar] [CrossRef] [PubMed][Green Version]

Helal, H.G. (2012). Sprouted barley grains on rice straw and Acacia saligna and its effect on performance of growing barki lambs in Sinai. Proc. of the 5th Animal Wealth Research Conf. in the Middle East & North Africa, 1-3: 331-346.

ISSN: 2537-0804 eISSN: 2537- 0855

Henry, R.J. (1965). Clinical Chemistry. Principles and Technics, P. 293.

Highstreet, A.; P.H. Robinson; J. Robison and J.G. Garrett (2010). Response of holstein cows to replacing urea with a slowly rumen released urea in a diet high in soluble crude protein. Livestock Sci., 129:179-185.

Jackson, M.L. (1958). Soil Chemical Analysis. Constable and Company, Ltd, England.

Kaur, K.; Kaushal, S.; Rani, R. Chemical composition, antioxidant and antifungal potential of clove (*Syzygium aromaticum*) essential oil, its major compound and its derivatives. *J. Essent. Oil-Bear. Plants* 2019, *22*, 1195–1217. [Google Scholar] [CrossRef]

Kingston-Smith .A.H.R.J.Merry , D.K.Leemans, H .Thomas and M.K.Theodrou , 2005. Evidence in support of a role for plant –mediated proteolysis in the rumen of grazing animals Br.J.Nutr., 93:73-79.

Laredo,M.A. and D.J.Mison ,1975a .The pepsin souble

Lemmens, E.; Moroni, A.V.; Pagand, J.; Heirbaut, P.; Ritala, A.; Karlen, Y.; Delcour, J.A. Impact of cereal seed sprouting on its nutritional and technological properties: A critical review. *Compr. Rev. Food Sci. Food Saf.* 2019, *18*, 305–328. [Google Scholar] [CrossRef][Green Version]

Mahmoud, A.H.; A.M. El-Anany (2014). Nutritional and sensory evaluation of a complementary food

ISSN: 2537-0804 eISSN: 2537- 0855

formulated from rice, faba beans, sweet potato flour, and peanut oil. Food Nutr. Bull., 35(4): 403- 413.

Moghaddam, A.S.; Mehdipour, M.; Dastar, B. The determining of digestible energy and digestibility coefficients of protein, calcium and phosphorus of malt (Germinated Barley) in broilers. *Int. J. Poult. Sci.* 2009, *8*, 788–791. [Google Scholar] [CrossRef][Green Version]

Morgan, J., R.R. Hunter and R. O'Haire, 1992. Limiting factors in hydroponic barley grassproduction. In the proceeding of the 8th International congress on soil less culture, pp: 241-261.

Norton, B.W. (2003). The Nutritive value of tree legumes. In: Forage Tree Legumes in Tropical Agriculture, Gutteridge R.C and Shelton H.M, (eds). pp.43.

Nutrgrass ,2007.the jointing stage :When nutrients reach their peak http://www.nutrigrass.com/jointingstage.htm

Opera, Y.; K. Shimbayashi, and T. Yonemura. 1975. Change of ruminal properties of sheep during feeding urea diet. Jpn. J. Zootech. Sci. 46:140-145.

Patton, C.J. and Crouch S.R. (1977). Enzymatic determination of urea by calorimetrically method Anal. Chem., 49: 464.

Peer, D.J. and S. Leeson, 1985b. Feeding value of hydroponically sprouted barley for poultry and pigs. Animal Feed Science and Technology, 13: 183-190.

Popp ,D.P.,D.J. H.Ternouth ., Poppi,D.P.,D.J.Minson and J.H.Ternouth ,1981.studies of cattle and sheep eating leaf and stem fraction of grasses II .factors controlling the retention of feed in the reticulo-rumen .Augst,J.Agric. Res., 32:109-121.

Rico, D.; Peñas, E.; García, M.D.C.; Martínez-Villaluenga, C.; Rai, D.K.; Birsan, R.I.; & Martín-Diana, A.B. Sprouted barley flour as a nutritious and functional ingredient. *Foods* 2020, *9*, 296. [Google Scholar] [CrossRef] [PubMed][Green Version]

Saidi, A.M.A.; Jamal, A.J. The biological and economical feasibility of feeding barley green fodder to lactating awassi ewes. *J. Anim. Sci.* 2015, *5*, 99–105. [Google Scholar] [CrossRef][Green Version]

Salisbury, M.W.; C.R. krehbiel; T.T. Ross; C.L. Schultz and L.L. Melton (2004). Effects of supplemental protein type on intake, nitrogen balance and site and extent of digestion in white face wethers consuming low-quality grass hay. J. Anim. Sci., 82: 3567-3576.

SAS (1998). User guide: statistics version 6, 4th ed., Vol. 2 SAS Institue Inc., Cary. NC. USA.

SAS Institute. *SAS Users Guide: Statistics*; SAS Institute Inc.: Cary, NC, USA, 2008.

Shoukry, M.M. (2013). An overview on the potential of using agricultural by-products in feeding ruminants. 14 Animal nutrition the scientific conference, pp: 26-29.

ISSN: 2537-0804 eISSN: 2537- 0855

Sneath, R. and F. McIntosh, 2003. Review of hydroponic fodder production for beef cattle. Department of Primary Industries: Queensland Australia 84. McKeehen, pp: 54.

Tudor, G., Darcy, T., Smith, P. and Shallcross, F. 2003. The Intake and LiveWeight Change of DroughtThomas, T.A., 1977. An automated procedure for the determination of soluble carbohydrate in herbage. Journal of Science of Food and Agriculture, 28: 639-642.

Tudor, G.; Darcy, T.; Smith, P.; Shallcross, F. The Intake and Live Weight Change of Drought Thomas, T.A., 1977. An automated procedure for the determination of soluble carbohydrate in herbage. *J. Sci. Food Agric.* 2003, *28*, 639–642

Van Soest, P.J. (1994). Nutritional ecology of the ruminant. Cornell University Press, New York, NY.

Van Soest, P.J.; Robertson, J.B.; Lewis, B.A. Methods fordietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. *J. Dairy Sci.* 1991, *74*, 3583–3597. [Google Scholar] [CrossRef]