An-Najah National University

Faculty of Graduate Studies

The Biological and Economical Feasibility of Feeding Barley Green Fodder and its Modifications on Lactating Awassi Ewes

By

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Dedication

To my Mother soul, Father, Sisters and Brothers.

To my Wife and my Family

To my Teachers

To my Friends

I dedicate this thesis

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الإقرار

انا الموقع ادناه مقدم الرسالة التي تحمل عنوان:

The Biological and Economical Feasibility of Feeding Barley Green Fodder and its Modifications on Lactating Awassi Ewes

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Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

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List of Abbreviations

A.O.A.C	American Official Analytical Chemist
AH	Almoundhulls
ADF	Acid Detergent Fiber
BW	Body Weight
Ca	Calcium
CF	Crude Fiber
CP	Crude protein
DM	Dry matter
EE	Ether extract
FI	Feed Intake
GCC	Gulf Cooperation Council
HB	Hydroponic Barley
ME	Metabolizable Energy
NDF	Neutral Detergent Fiber
NRC	National Research Council
OC	Olive Cake
P	Phosphorus
PCBS	Palestinian Central Bureau of Statistics
TMR	Total mixed ration
TS	Total solid
SAS	Statistical Analysis System

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The Biological and Economical Feasibility of Feeding Barley Green Fodder and its Modifications on Lactating Awassi Ewes

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Abstract

The objectives of this experiment were to investigate the botanical and biological value of hydroponic barley (HB) as a feed ingredient for lactatingawassi ewes. Three forms of HB were investigated. The first was planting barley grains alone (HB) while in the second and third were planting barley grains mixed with olive cake (HBOC) and almond hulls (HBAH). The green fodder produced from these three forms was used in feeding 4 lactating ewes in each group being fed one of the HB forms for 70 days and performance and milk parameters were tested. Results of the experiment showed that the green fodder yield in 8 days germination cycle was 6.6,6.5 and 7.5 kg per 1 kg barley grains of green fodder from HB,HBOC and HBAH,respectively. Mixed barley grain with OC and AH to barley grains as germination media had no advantages in regard to biomass and nutritive value. The form of HB had no effects on milk yield, milk composition, feed intake, body weight changes; however, HB of different forms had positive effects on ewe's healthy conditions, mortalities, conception rates and abortion. In conclusion HB of any form can be used as feed for lactating sheep as cost of feed can be reduced by 42% under HB feeding.

Chapter One

Introduction

Chapter One

Introduction

The technology of green fodder production is especially important in the regions as Palestine where forage production is limited (Abu Omar et al, 2012).

It is well documented that feed costs make more than 75% of total production costs of sheep projects (Abu Omar et al., 2012). To overcome this situation attempts were made to feed a non-conventional feed for sheep during summer where the range land fodders is at minimum as the green fodder as part of ewes' diets.

The green fodder is produced from grains, having high germination rate and grown for a short period of time in a special chamber that provides the appropriate growing conditions (Sneath and McIntosh, 2003). The adoption of this technique has enabled production of fresh forage from oats, barley, wheat and other grains (Rodriguez-Muela et al., 2004). The green fodder yield varies according to type of grain. It was reported by previous research that 1 kg of barley grains produced a green fodder yield ranging from 7 to 10 kg (Mukhopad, 1994, Shtaya, 2004). Hydroponic technique can be used for green fodder production of many forage crops in a hygienic environment free of chemicals like insecticides, herbicides, fungicides, and artificial growth promoters. It is a technique for high fodder yield, year round production and least water consumption (Mukhopad, 1994). Unlike field production system that use run-to-waste irrigation practices, the hydroponic fodder system uses recirculation system, thus reduce the waste water. It has been reported that hydroponic fodder production requires only about 2-3% of that water used under dry field conditions to produce the same amount of fodder. Fodder produced hydroponically has a short growth period 7–10 days and does not require high-quality arable land, but only a small piece of land for production to take place (Shtaya, 2004). It has high feed quality, rich with proteins, fiber, vitamins, and minerals (chung et al., 1989; Leontovich and Babro, 2005). All these special features of hydroponic system, in addition to others make it one of the most important agricultural techniques currently in use for green forage production in many countries especially in arid and semiarid regions of the world (Al-Karaki, 2011a). However, determining the best forage crop is an important matter in producing highest fodder yield, quality, and at the same time considering the economic import in the process of hydroponic green fodder production by saving of seeds cost.

The majority of sheep raised locally is of the Awassi breed (PCBS, 2010). It is a fat-tailed breed. Under the extensive and semi intensive sheep production system that is adopted by farmers' at large scale, feeding sheep in the off season resulting great expenses on concentrated and roughage feeds.

There are some arguments about the use of the sprouting grains for convenience of green forage production in hydroponics system to be as part of feed in livestock feeding systems (Rajendra et al., 1998; Tudor et al., 2003). Sole feeding of green fodder did not support the expected production traits in the animals whereas feeding in conjunction with dry fodder improved its utilization (Rajendra et al., 1998).

The biological and economical performances of green fodder and their effects when fed as part of lactating Awassi ewes diet is not known under local conditions and need to be evaluated. Therefore, this study was undertaken to determine and assess that under Palestinian conditions.

Chapter Two
Literature Review

Chapter Two

Literature Review

The limitation of forage and the prevailing arid and semi arid conditions is a well known common problem in Palestine (Abo Omar et al., 2012). The hydroponic green fodder is produced from cereal grains that are grown for a short period of time in soilless facilities (Sneath, and McIntosh, 2003). Producing up to 10 kg of fresh green fodder out of 1 kg of cereal grain proved to be an important achievement (Kruglyakov, 1989).

Several types of cereal grains can be used in the production of green fodder, wheat, barley, oat, corn and several other cereal grains. (Rodriguez-Muela, et al., 2004). Recent research showed that green fodder yield can reach 10 kg depending on type of grain and the growing conditions (Fazaeli et al., 2012; Al-Ajmi et al., 2009; Mukhopad, 1994; Buston et al., 2002) indicating that barley and wheat were the most appropriate.

Cuddeford, (1989) showed that the nutrient composition of green fodder changed by the growing cycle. Fiber content, for example, was reported to be increased from 3.75% in cereal barley grains to 6% in a 5-d green barley fodder (Chung et al., 1989). Peer and Lesson (1985) showed that dry matter digestibility changed with growing period, where digestibility at d-4 was superior.

Morgan et al (1992) and Peer and Lesson (1985a) reported that protein content of green fodder is similar to barley grain, where the crude protein was higher in the green barley because of the relative decrease of other components.

Several researches have been conducted to determine the feeding value of green fodder (Thomas and Reddy, 1962; Peer and Lesson, 1985a; Shtaya, 2004; 2011; Fazaeli et al, 2012). However, results were not consistent. These authors noted that the dry matter (DM) intake of green fodder by feedlot cattle and dairy cattle were low due to its high moisture content. However, Tudor et al. (2003) reported an improvement in the performance of steers when given restricted hay diet plus 15.4 kg fresh hydroponics green fodder (about 1.8 kg added DM). It can be concluded that the biological and economical viabilities of production of green fodder will depend on sprouting systems, type and quality of the grain, particularly the germination rate, culturing conditions, management, and the local conditions (Fazaeli et al., 2011). However, using some by-products (olive cake) as media proved to be of certain advantage as increasing the dry matter and green fodder nutritive value (Shtaya, 2004).

Reducing agricultural water use while maintaining or improving economic productivity of the agricultural sector is a major challenge in arid and semiarid regions. Irrigated agriculture is the major consumer of fresh water supplies in many parts of the world, particularly in relatively arid and semiarid regions like Jordan as well as Gulf Cooperation Council (GCC) (Al-Karaki, 2011b). The demand on scarce water resources in these countries is increasing with time for both agricultural and nonagricultural purposes.

Over recent years, severe shortages in food supplies for livestock have been experienced in Jordan and GCC countries as well as many other countries in the region, mainly, due to repeated droughts as well as shortages of water for irrigation (Al-Karaki, 2011b). Many projects to produce forages have been established during the last two decades to cover some green and dry forage needs in these countries (Al-Karaki, 2011b). However, scarcity of adequate fresh water supplies might pose challenges for sustainability of the field projects especially with utilizing ground water for irrigation, which is consumed in large amounts as these countries are characterized with very high rates of evapotranspiration and soils of low capacity to retain water. Therefore, methods and technologies that can contribute to improved water use efficiency and productivity merit closer consideration like hydroponic technique.

2.1 The Sprouting Process

Producing sprouts involves placing soaked barley in trays after being full saturated for sprouting for 7 days. Soaking process is important as facilitates metabolism of reserve materials which is utilized for growth and development (Morgan et al. 1992). Grain is often soaked or washed with a sterilizing solution to help minimize the risk of mould.

The yield and quality of sprouts produced is influenced by many factors such as soaking time, grain quality, grain variety and treatments, temperature, humidity, nutrient supply, depth and density of grain in troughs and the incidence of mould. Maximum sprout yield can be achieved through using clean and free of broken grains. Cereal seeds germinate equally well under dark or light conditions (Bartlett 1917, Whyte 1973 and Chavan and Kadam 1989). Several sprout production systems are available worldwide. These systems are furnished with suitable tools and equipment that facilitate production of spouts. Access to water, electricity, nutrients and sterilizing agents is required.

2.2 Dry Matter Changes with Sprouting

The germination process causes losses in dry matter (DM), however, some gain in DM from photosynthesis (Morgan et al., 1992). The DM losses vary between 7 and 47%. The sprouting yield depends on several factors such as irrigation, water quality and pH, grain preparation, grain quality and variety, seeding density, temperature and growing duration (Al Karaki, 2011a).

2.3 Nutrients in Cereal Grain and Sprout

The metabolisable energy (ME) levels of sprouts on DM basis were similar to grain which was around 10 to 13 mega joules (MJ)/ kg. Crude protein (CP) ranges from 14 to 24.9%. Both sprouts and grain are low in calcium and require additional calcium in the diet to correct the Ca: P ratio (Fazaeli et al., 2012).

2.4 Nutrient changes with sprouting grain

Enzymes included in grains would be activated by the soaking process then breakdown storage compounds in grains into more simple and digestible fractions as simple sugars, amino acids and free fatty acids (Cuddeford, 1989). There is an overall reduction in dry matter (DM) and total energy. Total weight of protein stays similar, however due to DM loss, the protein percentage increases giving an apparent increase in protein. There is an increase in fiber and some vitamins and a reduction in antinutritional compounds (Cuddeford, 1989).

The desirable nutritional changes that occur during sprouting are mainly due to the breakdown of complex compounds into a more simple form, transformation into essential constituents, and breakdown of nutritionally undesirable constituents (Chavan and Kadam 1989). Increased lipolyticactivity during germination and sproutingcauses hydrolysis of triacylglycerols to glycerol and constituent fatty acids (Chavan and Kadam 1989).

Lorenz (1980) concluded that the sprouting of grains resulted in the following: increased enzyme activity, a loss of total DM, increase in total protein, change in amino acid composition, decrease in starch, increases in sugars, a slight increase in crude fat and crude fiber and increase the amounts of certain vitamins and minerals. Most of the increase in nutrients are not true ones; they simply reflect the loss of DM, mainly in the form of carbohydrates, due to respiration during sprouting. As total carbohydrates decreases, the percentage of other nutrients increases.

Chung et al. (1989) found that the fiber content increased from 3.75% in unsprouted barley seed to 6% in a 5-day sprout. The growing conditions and barley variety can have a large effect on the composition of the grass at any particular stage of development, so grass produced from different hydroponic units will almost certainly vary in composition even if harvested at the same age (Cuddeford, 1989).

2.5 Changes in Protein Due to Sprouting

Chavan and Kadam (1989) reported an increase in protein, during the sprouting process, others a decrease in protein, while few researchers indicated a non-significant differences due to sprouting cereals (Chung et al, 1989). The increase in protein content has been attributed to loss in dry weight, particularly carbohydrates, through respiration during germination. Higher germination temperature and longer sprouting time means greater losses in dry weight and increases in protein content (Chavan and Kadam, 1989). Thus, the increase in protein is not true, but only apparent (Peer and Leeson 1985a). Longer soaking periods were also found to reduce protein attributable to the loss of low molecular weight nitrogenous compounds during soaking and rinsing of the seeds. Chung et al. (1989), found that leakage of solutes to be fastest at the start of germination and coming to a halt after about one day. Solutes that leaked included proteins, amino acids, sugars, organic acids, and inorganic ions. Chavan and Kadam (1989) observed a decrease in water-soluble proteins when wheat seeds were soaked at 10ºC for 2 days prior to sprouting. Similarly Chavan and Kadam (1989) observed a decrease in soluble protein of barley grains after prolonged soaking until the second day of germination. Losses were attributed to solubilization and leaching of proteins by the germinating embryo during the early germination period when there is little proteolytic activity developed in the seed. Morgan et al. (1992) found that changes in the ash and protein contents occur rapidly from day 4 corresponding with the extension of the radicle (root), which allows mineral uptake. The absorption of nitrates facilitates the metabolism of nitrogenous compounds from carbohydrate reserves, thus increasing the levels of crude protein (CP).

Morgan et al. (1992), showed that the CP content increases progressively with age, reaching a maximum of 48% at day 8. These increases are due partly to the absorption of nitrogen from the nutrients solution and to the concentration of nitrogenous compounds in a reduced mass of DM. When Flynn et al. (1986) calculated the weights of CP at the beginning and end of an 8-day cycle where they found that the recovered weights of CP and true protein had actually decreased significantly, by 7% and 24%, respectively. Chung et al. (1989) found an initial depression in protein content by the second day of sprouting, followed by a return to pre-germination protein levels with the same trend observed in the ash (minerals) content.

Although the net change in total protein content is usually non-significant, very complex qualitative changes are reported to occur during soaking and sprouting of seeds. The storage proteins of cereal seeds are partially hydrolyzed by proteolytic enzymes, which is evidenced by an increase in water-soluble proteins and free amino acids (Nielson et al. 1977 and Chavan and Kadam 1989). In wheat the water soluble proteins were found to increase six folds after 10 days of sprouting. The storage proteins of cereal grains are classified as albumins (water soluble), globulins (salt soluble), prolamins (alcohol soluble), glutelins (acid or alkali soluble) and residue or insoluble proteins (Chavan and Kadam 1989).The prolamins and glutelins together with residue proteins constitute more than 80% of the total seed proteins (Chavan and Kadam 1989). These protein fractions, particularly prolamin, are known to be deficient in lysine and are inversely correlated with the seed protein content (Kent-Jones and Amos 1967, Salunkhe et al. 1984, Chavan and Kadam 1989). Hence, the conversion of this fraction into albumins and globulins during sprouting may improve the quality of cereal proteins. Many studies have shown an increase in lysine with sprouting (Chavan and Kadam 1989) with the suggested mechanism being the degradation of prolamins into lower peptides and free amino acids to supply the amino groups, which are possibly used through transamination to synthesize lysine. The benefit directly to the ruminant animal would be questionable since bacteria in the rumen degrade the majority of highly digestible nutrients.

2.6 Changes in Antinutritional Factors

Phytic acid occurs primarily in the seed coats and germ of plant seeds. It forms insoluble or nearly insoluble compounds with minerals including Ca, Fe, Mg and Zn. Diets high in phytic produces mineral deficiency symptoms in experimental animals (Chavan and Kadam 1989). The sprouting of cereals has been reported to decrease the levels of phytic acid.

Polyphenols and tannins usually present in cereals like sorghum, barley and millet have been recognized as antinutritional factors. These are known to inhibit several hydrolytic enzymes, such as trypsin, chymotrypsin, amylases, cellulases and β-galactosidase (Chavan and Kadam 1989). In addition they bind with proteins and form tannin-protein complexes, thus making protein unavailable.

Detrimental effects of polyphenols and tannins on the availability of minerals and vitamin have been reported (Salunkhe et al. 1984 and Chavan and Kadam 1989). Chavan and Kadam (1989), concluded that sprouting treatment does not decrease the tannin content of grain, but favours the formation of complexes between tested tannins and endosperm proteins. The problem of tannin however is not significant in low tannin types and other cereals that do not contain appreciable amounts of tannins.

2.7 Livestock Performance from Sprouts

There have been many trials conducted by researchers throughout the world on livestock performance from sprouts. These trials have been conducted with dairy cattle, beef cattle, pigs and poultry. The majority of these trials have found no advantage to feeding sprouts compared to other conventional livestock feeds (Tudor et al, 2003).

Tudor et al. (2003) conducted a trial of livestock performance from sprouts under Australian conditions. Most of the trials on livestock performance from hydroponic sprouts show no advantage to including them in the diet, especially when it replaces highly nutritious feeds such as grain. From a theoretical perspective performance improvements occur if the supplement supplies the primary limiting nutrient(s) or improve feed use efficiency such as the situation that Tudoret al. (2003) experienced with steers on protein deficient hay.

Hydroponic sprouts are highly nutritious however the challenge to their use is finding circumstances where their benefits outweigh their costs.

Cuddeford (1989) describes some possible advantages of hydroponic sprouts for horses such as reduced starch and dust.

Tudor et al. (2003) measured intake and live weight change in 17 steers that received low quality hay and barley sprouts over 70 days. During the first 48 days cattle ate 1.9 kgDM/head/day of sprouts (15.4 kg wet weight) and 3.1 kgDM/head/day of poor quality hay and gained1.01 kg/head/day. Energy intake was 47 MJME/head/day, which was considered by nutrition standards to only be sufficient for low weight gains of up to 200g/head/day. This high performance could not be explained by energy and protein intakes. During the next 22 days sprouts were restricted to 1.6 kgDM/head/day (13 kg wet weight) and ad lib hay intake was 7.8 kg DM/head/day. Energy intake increased to 74 MJME/head/day and cattle gained 0.41 kg/head/day, which conformed to nutrition standards.

Hillier and Perry (1969) fed cattle with four levels of supplemental oat sprouts (0, 0.63, 0.95, 1.26 kg DM) on both low and high-energy diets. They found no effect on digestibility of DM, protein, fiber, ether extract, nitrogen free extract or energy.

Peer and Leeson (1985a) as cited in Morgan et al. (1992) found that pigs fed 4-day-oldsprouts gained significantly less weight than those fed barley grain.

Pandey and Pathak (1991) fed five crossbred (*Bostaurus x Bosindicus*) cows(3-4 years old and 350 – 410 kg live weight) ad lib on artificially grown barley fodder during their 3rd to 5thmonth of their second lactation. Voluntary intake of fresh sprouts was 50.38 kg/day or 7.13 kg DM. The mean dry matter intake was 1.93% of live weight and milk yield was 9.13 kg/day. They concluded that DM intake was a limiting factor for sole feeding and for high milk yielding cows supplementation of adequate concentrate was necessary.

Reddy et al. (1991) conducted 2 experiments with 8 crossbred (On gole x Holstein) cows. The first experiment used 8 cows (5-6 years old and 340 – 350 kg live weight) in their 2nd and 3rd lactation and producing 7-8 kg milk/day. Half received a concentrate mix plus ad lib paddy straw. The other half received the same ration except half the concentrate mix was replaced by 20 kg of fresh 8-day old barley sprouts. The second experiment used 8 cows (5-6 years old and 350 – 370 kg live weight) in their 2nd and 3rd lactation and producing 5-6 kg milk/day. Half received a concentrate mix plus ad lib paddy straw. The other half received the same ration except 25% of the concentrate mix was replaced by10 kg of fresh 8-day-old barley sprouts. In both experiments there was no significant difference in DM intakes, milk yields or quality. Comparing these two experiments the cattle receiving 20 kg of sprouts had higher DM intakes as a percentage of live weight (3.14%) compared with the cows that received 10 kg of sprouts (2.6%).

Grigor'ev et al. (1986) fed two groups of 8 cows, at the same stage of lactation, for 101 days on mixed feeds based on maize silage. Replacing 50% of the maize silage with 18 kg of hydroponic barley grass increased milk yield by 8.7% although milk fat was depressed.

Chapter Three
Materials and Methods

Chapter Three
Materials and Methods

3.1 Experimental Site:

3.1.1 Experiment I: Cultivation Procedure:

production of HD was performed at a private sheep farm in Tulkarm. A small germination unit was established and furnished with stands and trays. The Unit was computerized to control air conditions, temperatures ventilations, irrigation and lighting system.

In the germination unit, 11 trays on stands were planted with barley grains alone (HB), in another 11 trays, grains were planted with 0.5 kg destoned olive cake (HBOC) as media, while the rest of trays were planted with barley grains with finely ground almond hulls (HB AH) as media. Each tray was planted with 1 kg of barley grain alone (HB), barley grain with OC (HBOC) or grain with AH (HBAH). Metal trays of 90 x 30 x 4 cm were used in this experiment.

Seeds in trays were mist irrigated twice daily throughout the germination trial. However, second round of seeding was conducted to produce the amounts of green fodder required for performance trial. Fodder samples were collected from d-3 to d-8 of germination for later chemical analysis.

3.1.2 Experiment II: Performance trial:

Experiment II: feeding trial:

The feeding trial was conducted at the sheep farm mentioned above where 16 lactating Awassi ewes were used.

Ewes were randomly chosen from the sheep flock in a private sheep farm. Ewes were in second and third lactation period at start of the experiment. Ewes were separated and fed individually throughout the feeding trial. The green barley fodder was fed as part of total mixed ration (TMR), (Table1).

Ewes were randomly divided into four experimental groups with 4 ewes in each group in a complete randomized design. Group 1 served as control group and fed a regular lactation diet. Ewes in group 2 were fed only green barley fodder (HB). However, ewes in groups 3 and 4 were fed with green fodder with olive cake (HBOC) and green fodder with almond hulls (HBAH), respectively (Table 1).

Table (1): Ingredients and chemical composition of diets fed to Awassi ewes

Diets ingredient composition	Control	HB	HBOC	HBAH
HB	0	75	0	0
HB plus OC	0	0	75	0
HBplus AH	0	0	0	75
Concentrate (18% CP)	45	8	8	8
Wheat bran	30	15	15	15
NaCl	0	2	2	2
Wheat straw	25	0	0	0
Chemical composition				
Dry matter	90	36	43	39
Crude protein	13	15	13.5	12
Crude fiber	13	10.4	39	55.4
NDF	34	35.4	67.9	72.8
ADF	29	11.9	42.8	47
Ash	6	3.65	6.02	4.45
Calcium	1.5	2.2	2.3	2.1
Phosphorus	.6	1.1	1.9	2.0

Daily feed intake was recorded along with feed refusal. Feed and refusal samples were taken for later analysis. Ewes' body weight was monitored on biweekly basis. Milk production was measured daily. Milk samples were collected weekly for milk quality assessment. The duration of the performance trial was 70 days.

3.2 Chemical analysis:

Feed samples (intake and refusal) were analyzed for the proximate analysis fractions (DM, CP, ash, ether extract and crude fiber) as well as for ADF and NDF fractions using (AOAC,1990) procedures.

Milk was analyzed for DM, total protein, casein and fat using Gelbert procedure.

3.3 Economical evaluation:

All input costs (barley grain, water used, electricity, trays, stand..etc) were recorded as well as the yield (green fodder). The cost per kg green fodder was calculated. Cost of diets incorporated with green fodder was compared with the commercial diets.

3.4 Statistical analysis:

Analysis of variance was performed using the Statistical Analysis System (SAS, 2000). Differences among the means were determined by the Duncan's multiple range test with a significance defined at $P < 0.05$.

Chapter Four
Results

Chapter Four
Results

4.1 Nutrient composition of the experimental raw materials:

4.1.1 Olive cake:

The chemical analysis of the crude olive cake is presented in Table (2). Nutrient content of OC depends on type of OC. Different types of OC can be available locally. OC from old (traditional) oil pressers will have more fat contents compared to that obtained from modern pressers. (Abu Omar et al, 2011) .

Table (2): Chemical analysis of OC used in Germination of HB (DM basis)

Nutrients	Percent %
Dry matter	87.5
Crude protein	5
Crude fiber	29
NDF	58.9
ADF	46.3
Lignin	23.7
Ether extract	9.5
Ash	14.5
Gross energy	20.6
Calcium	12.5
Phosphorus	1.3

4.1.2 Almond Hulls:

The chemical analysis of AH is presented in table (3).

Table (3): Chemical analysis of raw AH. (%DM)

Nutrients	Percent %
Dry matter	**86.6**
Crude protein	**6**
Crude fiber	**15.2**
NDF	**32.6**
ADF	**26.5**
Lignin	**10.8**
Ether extract	**3.1**
Ash	**7.3**
Gross energy	**17.6**
Calcium	**2.9**
Phosphorus	**1.2**

4.2 Biomass of HB Produced from Different Procedures:

Results of this study showed similar yields obtained at the end of a 8-d germination period (Table 4). The net green product gain was 6.5 kg for HB alone and HBOC. However, green fodder gain was 7.5 kg when HB was cultivated with AH.

Table (4): HB yields from different hydroponic procedures, kg

	HB alone	HBOC	HBAH
Day 1	1	1.5	1.5
Day2	1.2	1.5	1.7
Day3	1.4	1.7	2.2
Day4	2.4	2.4	3.1
Day5	3.8	3.7	5.2
Day6	5.8	5.1	7
Day7	7.2	7	8.2
Day8	7.5	8	9

4.3 Chemical Composition of Different HB green fodder:

The chemical composition of HB of different procedures is shown in table (5). There were significant ($P < 0.05$) variations in most of the tested nutrients. The range in DM was from 18 to 30% for HB alone and HB with OC, respectively. Similar trend was observed in the crude fiber, NDF, ADF and Ash. Inclusion of OC and AH resulted in higher contents of crude fiber (Table 5). However, HB had higher (p <.05) levels of CP compared to other forms of HB.

Table (5): Chemical composition of different HB procedures, % (DM basis)

	HB alone	HB plus OC	HB plus AH	Sig
Dry matter	18.3a	30.69	29.59a	Sig
Crude protein	19.79a	13.31b	10.03b	Sig
Crude fiber	10.4b	40.1a	55.4a	Sig
NDF	35.4b	67.9a	72.8a	Sig
ADF	11.9b	42.8a	47a	Sig
Ash	3.65b	6.02a	4.45a	ns
Calcium	3.2b	6.3a	3.1b	ns
Phosphorus	4.1a	3.16b	3.13b	ns

Rows of different superscripts differ significantly at P<0.05.

4.4 Changes in Nutrients Crude Protein during the Germination Process:

The increase in CP content from d-1 to d-8 was almost 85% in HB when barley was germinated alone, however, slight increase was observed in HB protein content when germinated with OC or AH (Table 6).

Table (6): Changes in crude protein content during the germination process. (%DM)

	Day 3	Day 6	Day 8
HB alone	13.05	15.93	23.10
HB plus OC	14.81	14.5	18.28
HB plus AH	11.97	12.42	12.52

4.5 Milk yield and chemical composition:

Milk yields and milk composition are presented in table (7). Milk yield was not affected by the form of HB. Milk protein, milk fat and total solids (TS) were also not affected by feeding the different forms of HB (Table 7). Slight improvement in these parameters was observed in all treatment but was not significant.

Table (7): Composition of milk from Awassi ewes fed different forms of HB

	Control	HB	HBOC	HBAH	Sig
Milk yield, g/d	1102	1090	1110	1040	ns
Protein before	4.0	4.2	4.0	4.1	ns
Protein after	4.9	5.5	5.9	5.4	ns
% change	.9	1.3	1.9	1.3	ns
Fat before	5.1	5.0	4.9	5.0	ns
Fat after	5.8	6.1	5.9	6.0	ns
% change	.7	1.1	1.0	1,0	ns
TS before	16.0	16.2	15.8	16.0	ns
TS after	15.8	16.9	16.5	17.0	ns
%change	.2	.7	.7	1.0	ns

4.6 Ewes Body Weight Change:

Ewes' average live weight was increased during the entire feeding trial. Body weight of ewes fed the regular lactation diet gained similar to ewes fed the different forms of HB (Table 8).

Table (8): The economical results of the experiment

	control	HB	HBOC	HBAH	Sig.
Number of ewes	4	4	4	4	-
Weight change (kg)	6	4	4.5	5	ns
Average daily gain (g)	86	57	64	71	ns
Daily feed intake (kg)	3	4.4	4.0	4.2	ns
Cost of 1kg, feed NIS *	1.48^{a}	$.70^{b}$	$.60^{b}$	$.62^{b}$	Sig
Cost/ton, NIS**	1480a	700b	600b	620b	Sig

*New Israeli Sheqel

** based on the production cost of different HB is 463 NIS/ton, and , of HB, HBOC and HBAH, respectively.

Rows of different superscripts differ significantly at $P < 0.05$.

4.7 Conception rate and abortion

The rate of conception was the same in ewes in different feeding treatments.

No cases of abortion were observed in the experimental ewes. This indicated availability of nutrients in HB when fed alone or mixed with OC and AH.

Adequate levels of vitamin A (carotene) might be the explanation of maintaining pregnancy while consuming this type of diet.

4.8 Health problem and Mortality

No signs of disease or health problem were observed during the feeding trial.

The survival rate in experimental ewes was 100%. The nutrient supply was enough to maintain and cover energy requirements of experimental ewes. Good healthy conditions were observed along with the experiment route. Sizable mortalities are observed in similar heard consuming traditional feeds, especially is the area around the experimental site. Experimental rations are good enough to prevent mortalities

Chapter Five
Discussion

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Discussion

5.1 Nutrient Value of Olive Cake:

Results of the chemical analysis of the OC used in the germination process are similar to what was reported by previous research (shtaya, 2004). Laboratory analyses of OC showed comparable values to those associated with the OC resulted from the traditional olive presses (the three phase centrifugation extraction procedure (Molina Alcaide and Ya˜nez Ruiz, 2008). Crud Protein content was reported to be low and variable (from 48 to 106 g/kg DM) (Molina Alcaide and Ya˜nez Ruiz, 2008). Fibrous components vary depending largely on the proportion of stones in OC (Molina Alcaide and Ya˜nez Ruiz, 2008).

5.2 Nutrient Value of Almond Hulls:

The crude protein content of AH is low and similar to that of low to medium quality roughage (wheat and barley straw). However, its NDF value is good that makes it a suitable fiber source for ruminants. Nutrient analysis presented in this study is nearly the same compared to previous reports (Dairy Australia, 2013).

5.3 Hydroponic Barley Yield:

5.3.1 HB alone:

When barley seeds were germinated alone the HB yield was 6.5 kg of green fodder/ kg barley seeds. This value is the same to that was reported previously (Shtaya, 2004). However, Kruglyakov, (1989) reported a production up to 10 kg of fresh green fodder out of 1 kg of cereal grain.

Wheat, barley, oat or other cereal grains can be used in the production of green fodder (Rodriguez-Muela, et al., 2004).The green fodder yield depends on type of grain and the growing conditions (Fazaeli et al., 2012; Al-Ajmi et al., 2009; Mukhopad, 1994, Buston et al.,2002).

5.3.2 HB with OC:

The OC was used in the germination process as a media and to increase the DM content of the product. Addition of OC improved the DM of the green fodder. These results were similar to that reported by other research (Shtaya, 2004). However utilizing olive cake as a media for germination increased the HB mass by 20%. The extra nutrients available in the raw olive cake could be responsible for that improvement in the HB nutritive value.

5.3.3 HB with AH:

Similarly the AH was used as a media for the germination process of HB. Similar effects on the fodder yield as that of OC were observed. Nutrients in AH might be the reason for the improvement of the green fodder yield.

5.4 Composition of the Different Forms of HB:

Cuddeford (1989) showed that the nutrient composition of barley green fodder changed by the growing cycle. Fiber content, for example, was reported to increase from 3.75% in cereal barley grains to 6% in a 5-d green barley fodder (Chung et al., 1989). Results of this study showed that CP content of HB germinated alone was increased by 12 - 18% while the increase of CP of HB when germinated with OC was from 14.8 to 18%. In case of HBAH the CP content increased by 12 to 12.5%. Chavan and

Kadam (1989) reported that some reports indicated an increase in protein, others a decrease in protein, while a few indicated non-significant differences due to sprouting cereals. The increase in protein content has been attributed to loss in dry weight, particularly carbohydrates, through respiration during germination. Higher germination temperature and longer sprouting time means greater losses in dry weight and increases in protein content. Thus, the increase in protein is not true, but only apparent (Peer and Leeson 1985a). Longer soaking periods were also found to reduce protein attributable to the loss of low molecular weight nitrogenous compounds during soaking and rinsing of the seeds. Chavan and Kadam (1989) observed a decrease in water-soluble proteins when wheat seeds were soaked at 10ºC for 2 days prior to sprouting. Similarly, Chavan and Kadam (1989) observed a decrease in soluble protein of barley grains after prolonged soaking until the second day of germination. Losses were attributed to solubilization and leaching of proteins by the germinating embryo during the early germination period when there is little proteolytic activity developed in the seed. Morgan et al. (1992) found that changes in the ash and protein contents occur rapidly from day 4 corresponding with the extension of the radicle (root), which allows mineral uptake. The absorption of nitrates facilitates the metabolism of nitrogenous compounds from carbohydrate reserves, thus increasing the levels of crude protein (CP). Grass was grown in a controlled environment chamber at 21ºC and 5,000 lux illumination for 16 hours daily (Sneath and McIntosh, 2003). On a DM basis this increase represented 48%, half of which was apparent due to a 16% loss in DM by day 8.Morgan et al. (1992), showed that the CP content increases progressively with age, reaching a maximum of 48% on day 8. These increases are due partly to the absorption of nitrogen from the nutrients solution and to the concentration of nitrogenous compounds in a reduced mass of DM.

5.5 The feeding Trial:

5.5.1 Feed intake:

There are several factors described as influencing feed intake as milk production level, condition, temperature, shearing, type and quality of forage, pasturing system, breed, concentrate ration (Verkaik, 2001). The experimental diets were consumed the same by ewes under different forms of HB. However, the observed intake was similar to what was reported from previous research (Shtaya, 2004, Abu Omar, unpublished data).

5.5.2 Body Weight Change:

The ewes' average weight was nearly the same in ewes fed the different forms of HB. Although levels of CP in the experimental diets were lower than the levels recommended by NRC, ewes' performance was positive. This may be due to the effects of increased nutrients and the low antinutritional factors in HB.

Tudor et al. (2003) reported that most of the trials on livestock performance from hydroponic sprouts show no advantage to including them in the diet, especially when it replaces highly nutritious feeds such as grain. Cuddeford (1989) describes some possible advantages of hydroponic sprouts for horses.

Hillier and Perry (1969) fed cattle with four levels of supplemental oat sprouts (0, 0.63, 0.95, 1.26 kg DM) on both low and high-energy diets. They found no effect on digestibility of DM, protein, fiber, ether extract, nitrogen free extract or energy. Hillier and Perry (1969) found growth responses for poultry (Scott et al. 1951, Scott 1951, Scott and Jensen 1952, Slinger et al. 1952) and also increased gains for cattle when sprouted corn was added to the ration (McCandlish 1939). Morgan et al. (1992) found that pigs fed 4-day-old sprouts gained significantly less weight than those fed barley grain. Grigor'ev et al. (1986) fed two groups of 8 cows, at the same stage of lactation, for 101 days on mixed feeds based on maize silage. Replacing 50% of the maize silage with 18 kg of hydroponic barley grass increased milk yield by 8.7% although milk fat was depressed.

5.5.3 Milk yield:

Type of diet had an effect on both milk yield and milk quality. The relatively low averages of milk yield recorded can be explained by that the experiment was started one month after initiation of lactation and the general poor conditions of ewes used in the experiment. Most of available ewes in sheep farms are of similar quality. Milk yield observed in this study were lower compared with other findings reported by previous research especially when ewes fed HB with OC (Shtaya, 2004).

Chapter Six
Conclusions and Recommendations

Chapter Six
Conclusions and Recommendations

6.1 Conclusions

1- The yield of (HB), HBOC and HBAH was 6.5, 6.5 and 7.5 kg of the green fodder /1 kg seeds.

2- Milk yield and milk components from ewes were not affected by forms of HB.

3- Diet cost can be decreased by 42% when HB were used as part of ewes diets.

6.2 Recommendations:

1. Any form of HB can be used in feeding of lactating ewes without negative effects.
2. Supplementation of feed ingredients of bulky nature to HB may increase the nutritive value of HB as increase diets dry matter.

References

- Al-Ajmi, A., A. Salih, I. Kadhim and Y. Othman, (2009). Yield and water use efficiency of barley fodder produced under hydroponic system in GCC countries using tertiary treated sewage effluents. **Journal of Phytology, 1(5): 342-348**
- Abu Omar J, Daya R, and A. Salama Effects of different types of olive cake on the performance and carcass quality of Awassi lambs. **Anim Feed Sci Tech 2012; 171: 167-172.**
- Abu Omar, J., R. Daya and A. Salama. 2011. Effects of Different Types of Olive Cake on the Performance and Carcass Quality of Awassi Lambs. **Anim. Feed Sci. And Technol.**
- Al-Karaki, G. N. 2011. Utilization of treated sewage wastewater for green forage production in a hydroponic system. **J. Food Agric. 2011. 23 (1): 80-94**
- Al-Karaki, G. N. and M. Al-Hashimi 2011. **Green Fodder Production and Water Use Efficiency of Some Forage Crops under Hydroponic Conditions. ISRN Agronomy. 2012**.
- AOAC, 1990.Official methods of analysis. **Association of Official Analytical Chemists, Inc. Arlington, Virginia, USA.**
- Bartlett, J. M. (1917). **The chemical composition of green sprouted oats. Maine Agricultural Experimental Station.**
- Bhatty, R. S. (1969). "Note on the development of the proteolytic enzymes in germinating barley." **Cereal Chemistry 46: 74.**

- Buston, C.D.E., E.L. Gonzalez, B.A. Aguilera and G.J.A. Esptnoz, 2002.Forrajehidropónicounaalternativa para la suplementación caprinaen el semidesier to Queretano pp: 383. **XXXVIII Reunión Nacional de Investigación Pecuaria. (Puebla, México).**
- Chung, T. Y., Nwokolo, E. N. and J. S. Sim. 1989. Compositional and digestibility changes in sprouted barley and canola seeds. **Plant Foods Human Nutr.39:267- 278.**
- Chavan, J. and Kadam, S.S. (1989)."**Nutritional improvement of cereals by sprouting."**
- Chung, T., E.N. Nwokolo and J.S. Sim, 1989.Compositional and digestibility changes in sprouted barley and canola seeds. **Plant Foods for Human Nutrition, 39: 267-278.**
- Cuddeford, D., 1989. **Hydroponic grass. In Practice, 11(5): 211-214.**
- Dairy Australia. 2013. **Facts on alternative fiber sources. Daily Australian limited.**
- Fazaeli1, H., H. A. Golmohammadi, A. A. Shoayee, N. Montajebi, and Sh. Mosharraf. 2011. Performance of Feedlot Calves Fed Hydroponics Fodder Barley. **J. Agr. Sci. Tech. (2011) Vol. 13: 367-375.**
- Fazaeli, H.H.A. Golmohammadi, S.N. Tabatabayee and M. Asghari-Tabrizi. 2012. Productivity and Nutritive Value of Barley Green Fodder Yield in Hydroponic System. **World Applied Sciences Journal 16 (4): 531-539, 2012**
- Flynn, V., and O'Kiely, P. (1986).**Input/output data for the ACRON germination unit.**

- Grigor'ev, N. G., Fitsev, A. I., and Lesnitskaya, T. I. (1986)."Nutritive value of hydroponic feed and its use for feeding high-yielding cows."**Sel'skokhozyaistvennayaBiologiya7: 47-50**.
- Hillier, R. J., and Perry, T.W. (1969)."Effect of hydroponically produced oat grass on ration digestibility of cattle." **Journal of Animal Science 29: 783-785.**
- Kruglyakov, Yu. A., 1989.Construction of equipment for growing green fodder by a hydroponic technique. **Traktory-I Sel' skokhozyaistvennye Mashiny, 6: 24-27**.
- Kent-Jones, D.W. and A.J. Amos, 1967.Modern Cereal Chemistry.6th ed. Food Trade Press, London.
- Lorenz, K. (1980). "Cereal sprouts: composition, nutritive value, food applications." **Crit. Rev. Food Sci. Nutr. 13(4): 353-385.**
- McCandlish, A.C., and Struthers, J.R. (1938)."**The influence of sprouted grain on digestibility."Scot. J. Agr. 21: 141.**
- MOLINA-ALCAIDE, e., Yanez-ruiz, D.R. 2008.Poential use of olive ny products in ruminant feeding, a review. **Anom. Feed Sci. Technol. 147, 247-264 .**
- Morgan, J., Hunter, R.R., and O'Haire, R. (1992). Limiting factors in hydroponic barley grass production. **8th International congress on soilless culture, Hunter's Rest, South Africa.**
- Morgan, J., R.R. Hunter and R. O'Haire, 1992. Limiting factors in hydroponic barley grass production. **In the proceeding of the 8th International congress on soil less culture, pp: 241-261.**

- Mukhopad, Yu., 1994. Cultivating green forage and vegetables in the Buryat Republic. **Mezhdunarodnyi Sel' skokhozyaistvennyi Zhurnal, 6: 51-52.**
- Nielson, M.T., Meade, R.E., Paulsen, G.M., and Hoseney, R.C. (1977).Improvement of wheat protein quality by germination.**Tenth National Conference on Wheat Utilization Research, Tucson, Arizona.**
- NRC (1984).Nutrient requirements of beef cattle. **Washington D.C., National Academic Press.**
- Palestinian Central Bureau of statistics (PCPS). **2010. The annual bulletin.**
- Pandey, H.N., and Pathak, N.N. (1991). "Nutritional evaluation of artificially grown barley fodder in lactating crossbred cows." **Indian Journal of Animal Nutrition 8(1): 77-78.**
- Paterson, W. G. R., 1937: Sprouted maize for beef production. Results of Auchincruive experiment. **Scot. Farmer, 45: 1230**
- Peer, D.J., and Leeson, S. (1985a). "Feeding value of hydroponically sprouted barley for poultry and pigs." **Animal Feed Science and Technology 13: 183-190.**
- Peer, D.J., and Leeson, S. (1985b). "Nutrient content of hydroponically sprouted barley." **Animal Feed Science and Technology 13: 191-202.**
- Rajendra Prasad, Seghal, J.P., Patnayak, B. C., and Beniwal, R.K. (1998)."Utilization of artificially grown barley fodder by sheep." **Indian Journal of Small Ruminants 4(2): 63-68.**

- Reddy, M.R., Reddy, D.N., and Reddy, G.V.K. (1991). "Supplementation of barley fodder to paddy straw based rations of lactating crossbred cows." **Indian Journal of Animal Nutrition 8(4): 274-277**.
- Rodriguez-Muela, C., H.E. Rodriguez, O. Ruiz, A. Flores, J.A. Grado and C. Arzola, 2004. Use of green fodder produced in hydroponic system as supplement for lactating cows during the dry season. **In the Proceeding of the American Society of Animal Science, pp: 271-274.**
- Salunkhe, D.K., Chavan, J.K., and Jadhav, S.J. (1984).**Nutritional and Processing Quality of Sorghum. New Delhi, India, Oxford & IBH**.
- Scott, H.M., Gilsta, W.A., and Goffi, E.A. (1951). "Growth effects of certain supplements added to a corn soybean oil meal chick ration with and with-out antibiotics." **Poultry Science 30: 930.**
- Scott, M.L. (1951). **"The grass juice factor in turkey nutrition." Poultry Science 30: 293.**
- Scott, M.L., and Jensen, L.S. (1952)."The effect of antibiotics upon the requirements of turkeys for unidentified vitamins.**" Poultry Science 31: 986.**
- Slinger, S.J., Pepper, W.F., and Hill, D.C. (1952). "Interaction between penicillin and grass juice concentrate in turkeys.**" Poultry Science 31: 187.**
- Sneath, R. and F. McIntosh, 2003. Review of hydroponic fodder production for beef cattle. Department of Primary Industries: **Queensland Australia 84. McKeehen, pp: 54**.

- Shtaya, I. 2004. Performance of Awassi ewes fed barley green fodder. Master thesis. **AnNajah National University**
- SAS, 2000. SAS User's Guide: Statistics, Version fifth ed. SAS Inst., Inc., Cary, NC.
- SAS, 2000. SAS/SAT Guide for Personal Computers, Version 9.13 (SAS Institute Inc: Cary NC, USA).
- Thomas, J.W. and Reddy, B.S. (1962).Sprouted oats as a feed for dairy cows.**Quarterly Bulletin of the Michigan Agricultural Experiment Station.44: 654-655.**
- Tudor, G., Darcy, T., Smith, P., and Shallcross, F. (2003). **The intake and live weight change of drought master steers fed hydroponically grown, young sprouted barley fodder (Autograss), Department of Agriculture Western Australia**.
- Whyte, K.C. (1973). **The Complete Sprouting Cookbook. San Francisco, Troubator Press.**
- Yanez-ruiz, D.R. Molina . Alcarde, E., 2007. A comparative study of the effect of tow stage olive cake added to alfalfa on digestion and nitrogen losses in sheep and goats, **animal l. 227-232 .**

جامعة النجاح الوطنية
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التقييم الاقتصادي والحيوي لتغذية الشعير المستنبت ومعاملاته لأغنام العواسي الحلوب

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قدمت هذه الاطروحه استكمالا لمتطلبات الحصول على درجة الماجستير في الإنتاج الحيواني في كلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين .

2014

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الملخص

اجريت هذه الدراسة في مزرعة البركة في مدينة طولكرم لتقييم تأثير تغذية الشعير المستنبت ومعاملاته على أغنام العواسي الحلوب اقتصاديا وإنتاجيا . تم استنبات الشعير في وسط مائي باستعمال ثلاث طرق، كانت الأولى استنبات الشعير لوحده بينما كانت الثانية باستنبات الشعير مضافا إليه جفت الزيتون والثالثة باستنبات الشعير مضافا إليه قشر اللوز المطحون . استخدم الشعير المستنبت لمدة 8 أيام كعليقه لأغنام العواسي على مدار 70 يوم . تم قياس الأداء ، والإنتاج طوال فترة التجربة . كانت نتائج استنبات الشعير بواسطة الطرق الثلاث هي 6.5 6.6 و 7.5 كغم شعير مستنبت لكل كيلو غرام من حبوب الشعير على الترتيب . إضافة الجفت وقشر اللوز كجزء من وسط الإنبات للشعير لم يكن له الأثر الإيجابي إلا على الكتلة و القيمة الغذائية للشعير المستنبت. الشعير المستنبت لوحده لم يوثر على إنتاج الحليب وتركيب الحليب و استهلاك العليقه و وزن الحيوان ، ولكن الشعير المستنبت بكل أشكاله كان له الأثر الايجابي على صحة الحيوان ، نسبة الوفيات ، نسبة التلقيح و نسبة الإجهاض . كانت النتائج بإمكانية استخدام الشعير المستنبت بكل أشكاله كعليقه لأغنام الحليب وتخفيض تكلفة الإنتاج لغاية 42% من تكلفة العليقة .