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Chemical Composition of Dominant Range Plants at Southern West Bank

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List of Abbreviations

1. ADF: Acid detergent Fibers.
2. CF: Crude Fibers.
3. CP: Crude Protein.
4. DM: Dry Matter.
5. NDF: Neutral Detergent Fibers.
6. OM: Organic Matter.
7. N: Nitrogen.
8. P: Phosphor.
9. K: Potassium.
10. Mg: Magnesium.
11. Na: Sodium.
12. Ca: Calcium.

Abstract

Determining the nutritional quality of the main botanical components (grasses, forbs and shrubs) in semi- arid rangelands is essential for establishing a rangeland management plan. The aim of this study was to determine the chemical component of dominant rangeland plants and the change in chemical composition of grasses (*Avena sterilis*, *Poa bulbosa*,), forbs (*Pisium syriacum*, *Medicago rotata*, *Scorpurus muricatus*,), and shrubs (*Acacia cyanophylla, Atriplex halimus, Retama raetam, Artemisia herba-alba*), through seasons and at different sites. Four replicates from each plant were sampled during spring and summer seasons from BaniNoem and Sureif sites, after drying, samples were prepared for chemical analysis. The result showed that there were significant differences ($P \leq 0.05$) between vegetation groups (forbs, grasses, and shrubs) and among species in the same group in its chemical composition. Forage chemical composition is related to sampling seasons and stage of maturity. It was found that grasses had lower percentages of crude protein (CP) but higher crude fiber (CF), dry matter (DM), neutral detergent fiber (NDF), and acid detergent fiber (ADF) percentages than shrubs and Forbs. *P. syriacum* had the highest CP content (20.5%) during summer and (19.5%) during spring seasons and the lowest fat content (0.5%). *A. sterilis* showed the highest content of C. Fat, DM and ADF with 5.9%, 99.3%, 67.6% respectively, and the lowest content of CP (5.5%) during summer. *S. Muricatus* showed lowest DM content (16.1%) during spring season. CF ranged from (11.4 – 45.1%) for *M. rotate* and *A. herba-alba*, respectively. *P. bulbosa* showed the highest content of NDF

(81.1%), while the lowest content recorded for *A. cyanophylla* (38.8%). The lowest content of ADF was recorded for *A. halimus* (21.5%).

Ash content varied from 5.1% to 18.4%, contents of (K, Ca, Na, Mg) were within the range of livestock feed requirements except for P which was lower than animal feed requirements. Environmental condition had an effect on the chemical composition of range plants. At humid site that associated with high organic matter and high soil fertility had an effect on protein content and minerals of species, in arid site low soil fertility and hot summer affect the early maturity that associated with higher fiber content and low minerals during spring season compared to humid site.

In conclusion, forbs and shrubs were higher in CP content than grasses during spring and summer, and they were more than feed requirement of small ruminant. Grasses showed high content of fat and fibers. DM content of shrub species during summer was lower than grass and forbs content which recorded drastic increase during summer. Minerals content of species were around the normal levels except for P which recorded low contend during both seasons. As recommendation we have to focus our attention in rangelands rehabilitations on the best quality species like *P. syriacum*, *A. halimus* and *R. raetam*, and to increase shrub species which provide green forage with good nutrient source during the long and dry seasons. The result showed that P/Ca ratios were below the optimum levels, so Phosphorus supplementation may be necessary to meet the animal feed requirements; also concentrates supplementation is necessary during dry season. *Atriplex halimus* which is a halophytic species has the highest percentage of Na. The principal advantage of using *A. halimus* as fodder will have adverse effects due to the high minerals content of halophyte tissues which can be minimized in mixed diets.

Introduction

Natural rangelands provide feed for large number of livestock. It plays a vital role in national economy through provision of animal products for local consumption (Fatur and Abdel Ati, 2007). Browse plants, and herbaceous, make one of the cheapest sources of feed for ruminants (Ahamefule, et al. 2006). The rangeland in Palestine is of no less importance since it covers approximately 32% of the total area of the West Bank and Gaza Strip (PEnA, 1999). As other Mediterranean rangelands, Palestinian rangelands have been grazed by domestic livestock, mainly sheep and goats for at least 5000 years (Pearse, 1970; Noy-Meir and Seligman, 1979). These rangelands have a large number of plant species, which hold a high nutritive value (Qannam, 1998), and have direct economic value as feed, medicinal, forest and ornamental plants (ARIJ, 1997). It also represents different habitat for wild animals and birds.

Rangeland of Palestine is greatly affected by rainfall fluctuations, over grazing, absence of rangeland policies and legislations as will as uprooting of trees and cultivation of marginal lands (ARIJ, 1994; PEnA, 1999; Mohammed, 2000). In addition to that, the neglecting and misusing of natural resources during the Israeli occupation have caused a high rate of soil and land degradation, which have ultimately led to accelerating decrease in vegetation cover and productivity (Mohammed, 2000 and 2005). The palatable and good quality forage deteriorates or disappears (quantity and quality degradation) in addition to an increase in poisonous, unpalatable plants and severe soil erosion that ultimately lead to desertification in many rangeland areas (Mohammed, 2005). Rangeland varies in green biomass production, distribution, and nutritive value from year to year. According to Mohammed (2000 and 2005), the vegetation cover of the pastures in Eastern Slopes is enough for only 15 % of livestock feed requirement. Therefore, forage scarcity is prevalent and there is an urgent need for increase in feed resources in the arid zones of the rangeland (Aganga, et al. 2003). Forage quality is commonly evaluated by laboratory analysis for crude protein, fiber and digestibility. Generally, the quality of grasslands for livestock production is a result of plant species present, the amount of forage available and the chemical and physical characteristics of each species. Several studies have shown that forage nutritional quality has been affected with topography, botanical composition, soil characteristics, climate, season and stage of maturity (Aldana, et al. 2000). The potential yield of browse will provide a useful mean for the determination of stocking rate and indeed the carrying capacity of a range or land under grazing (Ahamefule, et al. 2006).

Objectives

The objective of this study were to

1. Study the chemical composition of some dominant rangeland plants, Which include:

    1.1 Grasses (*Avena sterilis* (السبيلة ,شوفان); *Poa bulbosa*,(نزعة)).

    1.2 Forbs (*Pisium syriacum,* (بريد)*; Medicago rotate*,(دريدرة); *Scorpiurus muricatus*,(العنجد)).

    1.3 Shrubs (*Acacia cyanophylla*,(السنط الأزرق.أكاسيا)*; A triplex halemus,* (القطف الملحي); *Retama Raetam,* (الرتم); *and Artemisia-Herba-alba*, (الشيح)).

2. Study the change in chemical composition of dominant range plant through seasons.
3. Evaluate the chemical composition of forbs and grasses under different environment.

Chapter One

1. Literature review

1.1 Natural Vegetation in Palestine

1.1.1 Rangeland in Palestine

Rangeland is the land which is used for grazing animals, it represents marginal, shallow soil, sloppy lands with precipitation less than 300/mm/yr. It is a land that not fit for cultivation (Palestinian agriculture low No (2)2003).

The area of range land in Palestine is estimated at 2,180,000 Dunums, which represent 32% of total area of West bank and Gaza strip (ARIJ, 1994; PEnA, 1999; Mohammed 2000), it was estimated that 70% of them located in Eastern slopes, where only 700,000 dunums were available to Palestinian livestock. Most of the available area (500,000 dunum) is located mainly in the Eastern slopes (Mohammed, 2000). The dominant range plants were herbaceous plants that grow and provide green vegetation for only 2-3 months and then dry out during the long, hot, and dry summer (Mohammed, 2005; Salama and Al-joaba 2008). These rangelands suffer from quantity and quality degradation represents in low productivity and the absence of shrubs and palatable species in addition to increase of unpalatable and poisonous plants such as *Sarcopoterium spinosum* and *Asphodelus aestivus* (Mohammed, 2005; Al-joaba, 2006; Salama and Al-joaba 2008). Large number of studies and researches were conducted to investigate the nutritive value of plants around the world, but such studies are rare and limited in Palestine.

1.1.2 Vegetation diversity

Palestine is known by its richness in vegetation diversity that reflects the high variability in its climate, topography, and other environmental factors (AL-joaba, 2006). There are four geographical territories existed in Palestine, Mediterranean, Irano-Turanian, Saharo-Arabian, and the Sudanian penetration. These territories are different in edaphic and climatic factors which have the direct impact on the vegetation diversity and distribution (Zohary, 1966; Danin, et al. 1975). Among these territories, a unique variable ecosystems that encounter for the different floral associations that contain 138 families of flora with 2780 plant species (Dothan and Danin, 1991; Danin, 2004), were distributed in five longitudinal belts; Jordan valley, eastern slopes, central highlands, semi-coastal region, and the coastal plain (PEnA, 1999). Palestine flora forms the woody plants, ornamental, medicinal, shrubby, and herbaceous plants. 60 species of natural trees, 90 species of bushes, and 149 species do not exist in other places were identified (Ali-shtayeh, 1995). The most dominant families are *Compositae* with 96 genera and 260 spp, *Graminae* with 87 genera and 198 spp, *leguminaceae* with 62 genera and 268 spp, *crucifera* with 63 genera and 124 spp, *labiatae* which is famous as medicinal plants with 23 genera and 99 Spp like *Salvia officinalis*, *Mintha piperita*, *Teucrium polium*…etc, *liliaceae* known for its beautiful flowers with 23 genera and 79 spp most of them used as ornamental. *Trifolium* which is used as forage plants contain 40 spp, *Medicago* genus contain 22 spp, and *Trigonella* genus contain 18 spp (Zohary, 1966; Danin, et al. 1975; Dothan and Danin, 1991). Woody (forest) species like *Pine* spp, *Ceratonia* spp, *Pistacia* spp, *Quercus* spp, and *Ziziphus* species is dominant woody vegetation (MOA 2005).

According to Al-joaba (2006), about 124 plant spp were identified in BaniNoem, Sureif, and Dura most of them belong to Mediterranean and Irano-Turanian plant geographical territories.

1.1.3 Vegetation condition

Natural vegetation in Palestine has been shaped by many factors that were mentioned above. These factors with misuse of rangeland led to desertification (Mohammed, 2005; Salama & Al-joaba 2008). Few scientific reports and studies were carried out on vegetation condition in Palestine, most of them focused on number of species and identification of these species only on certain locations or habitats. Results of research which carried out in the southern part of West Bank (Eastern Slopes) indicated that the mentioned factors led to change in the botanical composition by increasing unpalatable species such *Sarcopoterium spinosum* and *Asphodelus aestivus* in grazed plots. The palatable species such as *Medicago* spp, *Bromus* spp, *Hordium* spp, *Poa bulbosa*, and *Avena sterilis* are the dominant species at ungrazed plots (Mohammed, 2005; Salama & Al-joaba, 2008). According to Ali-Shtayeh and Jamous (2002), the number of threatened annuals and trees in West Bank was about 334 species from 81 families. Also, vegetation productivity of the same site was low 98.5 Kg du^{-1} and the total plant cover percentage was 83% (Mohammed, 2000 and 2005; AL-joaba, 2006). Rangeland production in Palestine covers only two months of livestock feed needs (Mohammed, 2000; Salama & Al-joaba, 2008).

1.1.4 Importance of rangeland vegetation to livestock

The rangelands in arid and semi-arid areas of the world provide primary products of grasses, legumes, and shrubs, which are converted into animal protein (IFAD, 2000). Forage is the main source of consumed mineral elements. Nearly all mineral elements can adversely affect an animal if included in the diet at low levels (Mayland and Shewmaker, 2001). Poor animal performance in the dry season is due to lack of protein, energy, minerals, carotene, and phosphorus (Msangi and Hardesty, 1993). Rangelands can play other important roles such as: water catchments areas, wildlife habitats, conservation of species, genetic resources, and aesthetic values (West, 1993; Harris, 2000). Palestinian rangeland used to be the main source of livestock feeds, which hold a high nutritive value and have direct economic value as feed (ARIJ, 1997; Qannam, 1998; Al-joaba, 2006; Salama & Al-joaba, 2008).

1.2. Livestock feed requirements

All animals require food to maintain there life, body structures, functions, and growth (Holechek, et al., 1989). Many wild and domestic herbivores require 7 to 9% crude protein for maintenance and 10 to 12% for lactation (Holechek, et al., 1989). Energy and protein are the most limiting nutrients to range livestock production (Holechek and Herbel 1986). Protein is composed of chain of amino acids that contain nitrogen as well as carbon hydrogen, and oxygen. Protein has many functions in animal body. They are important as enzyme, hormones, and anti bodies against diseases and agent for transport and storage of nutrients within the body. Protein is the principal constituent of organs and skin of animals. Protein cannot be stored by animal body like minerals, so continuous supply is required (Holechek and Herbel 1986). They also need 0.15 % to 0.20% P for maintenance and 0.25 to

0.30% for lactation (Holechek, et al., 1989; Catling, et al., 1994; Ganskopp & Bohnertn, 2001). Nearly all mineral elements, required by animals include the macro-elements P, K, Mg Ca, Cl, Na and S; the trace or micro-elements Co, Cu, Fe, I, Mn, Mo, Se, and Zn can adversely affect an animal if included in the diet at excessively high or low levels. Masters et al. (2005) proved that increasing the concentrations of sodium and potassium chlorides in the diet of ruminant significantly reduced feed intake, organic matter digestibility, and growth. Not only feeds is the main source of minerals for animals but also drinking water serve as sources of consumed mineral elements, also soil ingestion provides yet another source of soluble or extractable mineral elements (Mayland& Shewmaker, 2001). Also they showed that forage species normally have mineral nutrients exceeding that required by animals. The poor animal performance in dry season is due to lack of protein, minerals, and energy (Msangi & hardesty, 1993). Low levels of crude protein depress microbial activity in the rumen, reducing digestibility and intake. Fiber, consists mainly of cellulose, a large carbohydrate polymer. Whole grains, fruits and vegetables are rich in dietary fiber. It provides bulk to the intestinal contents and stimulates peristalsis (rhythmic muscular contractions passing along the digestive tract). Consequently, a lack of dietary fiber in the diet leads to constipation (Wikipedia encyclopedia). The ADF consist of cellulose and lignin. NDF is made up of four main chemical components. Quantitatively the largest, cellulose and hemicelluloses (hemicellulose + ADF) are potentially digestible, the other main components of NDF are lignin and cutin, but due to their complex chemical structures, it resists the attack of digesting microorganisms in the rumen of ruminant. NDF content of forages is important measurements because they provide an estimate of digestibility. As the lignin and cutin levels increase, the digestibility of its fiber will decrease. Lactating ruminants require NDF fiber content around 40 %. Many of the perennial species were just about perfect for providing excellent intake potential to ruminants. (Robinson, 1999; Leep and Dietz, 2008)

1.3. Chemical composition of rangeland plants

Rangeland plants consist of chemical compounds and nutrients such as carbohydrates (saccharides), fats (triglycerides), fiber (cellulose), minerals, proteins, vitamins, and water (Holechek, et al., 1989). These compounds, consist of elements such as carbon, hydrogen, oxygen, nitrogen, phosphorus, calcium, iron, zinc, magnesium, manganese, and so on. All of these chemical compounds and elements occur in various forms and combinations. The study of chemical composition of plants is concerned with the components of nutrients and there relation to need requirement by animals, but the study of nutrition is increasingly concerned with metabolism and physiological responses of the animal body to diet (Holechek, et al., 1989; Catling, et al., 1994; Gintzburger, et al., 1996; Ganskopp & Bohnertn, 2001). There are many factors which affect the chemical composition of rangeland plants.

1.4. Factors affecting the chemical composition of rangeland plants

1.4.1. Plant species

Many studies and researches were conducted around the world which proved that there is variability in chemical composition of plants according to plant group (life form) and species. Forbs, grasses, and shrubs are different in there content and composition, although species of the same group are different in its component (Ganskopp and Bohnertn, 2001; Distel, et al., 2005). This agree with Canan, (2004), who reported that grasses had lower concentrations of CP but higher CF, DM, NDF, and ADF concentration than legumes. Also, Barnes et al., (1990) described the macro and trace mineral concentration of shrub, forbs, and grass; he found that there is significant difference in the mineral concentrations between the three groups. According to Demarchi, (1968) there is a variability in chemical composition of plants due to plant species, groups and season changes. Also Demarchi, (1968) showed the significant difference in CP, C. fat and fiber between forbs, grasses and shrubs. Also differences between species of the same group were significant. Evitayani, et al., (2005), proved that the nutritive values of seven grass species were varied among species and seasons, the mean value of DM was 90.8 - 89.8 % in dry and rainy season respectively. Also, CP content varied among species, it ranged from 8.7 – 12 % during dry season, and 6.6 – 16.2 % during rainy season.

1.4.2 Plant part

Nutritive value were deferent according to plant parts, also the nutrient declines as plant become mature due to translocation of nutrient from leaves and stems to crowns and roots with the onset of dormancy (Gintzburger, et al. 1996). However, leaves of nearly all forages have higher crude protein, phosphorus, and cell soluble levels and lower fiber and lignin levels than those of stems. Stems low in quality because of they are high in level of lignifications (Holechek, et al., 1989; Gintzburger, et al. 1996). This fact agrees with Ibrahim, (1981), who found that chemical composition of shrubs changes according to type of tissue. Also Holechek, et al. (1989), indicated that vegetative parts of plants are very low in fats but seeds have high fat levels. Generally it is accepted that leaves of grasses, forbs, and shrubs are much higher in protein than the stems. Leaves of forbs and shrubs higher in protein than grass leaves and stems at the same stage of growth (Gintzburger, et al. 1996; Holechek, et al. 1989; Rumbaugh, et al. 1993). El-Shatnawi and Ereifej (2001), found that chemical compositions of carob seeds and pods were significantly different, CP contents were 6.8% and 16.7% for pods and seeds, respectively. The fiber contents of pods 9.1 % and seeds 11.5 %. The fat contents of carob pods and seeds were 1.2% and 2.9%, respectively. Considerable variations were observed in ash contents between pods and seeds (3.0 vs. 0.4% ash content). They found significant variation between pods and seeds in calcium and phosphorus content. Fruits and flowers of forbs and shrubs generally have much higher levels of cell soluble and protein than do leaves. Seeds from grasses have higher protein and cell soluble than those of other parts (Holechek, et al., 1989; Gintzburger, et al. 1996).

1.4.3. Season

Forage nutritive value on most rangelands varies tremendously between seasons. Protein and mineral contents decreased as the growing season progressed whereas fiber properties tended to increase with time (El-Shatnawi and Ereifej 2001). Annual grasses may lose 75% of their protein content and up to 52% of their phosphorous during the dry season (El-Shatnawi & Ereifej, 2001). The feeding value of the grass residue deteriorates after a month from harvesting (Demarchi, 1968; Holechek, et al., 1989; Garza, 1994; Corona, et al., 1998; Ganskopp & Bohnertn, 2001; Distel, et al., 2005; and Norman, et al. 2005). El-Hadrami, et al. (2004) showed the variability in chemical component in *Atriplex halimus* was related to sampling date, he indicated the high content of crude protein during the humid period compared with dry period. Bal, et al. (2006) found that there was a considerable variation among chemical compositions of sainfoin hays harvested at different maturity stages, the NDF, ADF contents of sainfoin were significantly increased with advancing maturity. The NDF and ADF contents ranged from 46.14 to 55.71 %, and 33.40 to 40.15 %, respectively. These results are in agreement with findings of Long, et al., (1999); and Ayed et al. (2001); Gulsen et al.(2004); and Kamalak, et al. (2005a), who found that cell wall contents (NDF and ADF) increased with maturity. On the other hand, CP, CT (crude tannin) and ash contents of sainfoin decreased with maturity and ranged from 13.05% to 19.50%, 42.66% to 105.12% and 7.18% to 8.31%, respectively. The CP, CT and ash contents of sainfoin harvested at vegetative stage were significantly higher than those obtained at flowering and late maturity stages (Bal, et al., 2006). The decline in CP concentration with advancing maturity occurs because of decrease in CP in leaves and stems and because stems, with their lower protein concentration, make up a larger portion of the herbage in more mature forage (Bal, et al., 2006).

1.4.4 Environmental factors

Quantity and quality of grazable material of pasturelands are affected by biotic environmental factors that including soil type, climatic regime, topography, botanical composition, and management (Angell, 1990; Bhat, et al., 1990; Hendrickson, 1997; Corona, et al., 1998; Aldana, et al., 2000; Mohammad, 2008a).

1.4.4.1 Topography

a- Slope and slope aspect

The influence of slope aspect has an important effect on the distribution characteristics of the vegetation (Al-Seikh, 2006; Mohammad, A. 2008b). The differences between Southern and Northern slopes derived mainly from differences in solar radiation which affect the soil surface temperature, evaporation, and soil moisture (Corona, et al., 1998; Kutiel, et al., 1999).

Corona, et al., (1998), found that topographic gradient significantly affected peak biomass production, fiber properties, protein and mineral contents. The favorable a biotic conditions in north-facing aspect enhanced the dominance of certain species (Zaady, et al., 2001; Kutiel, et al., 1999; Mohammad, A. 2008b). However, south-facing aspect provides more difficult conditions, such as high temperatures, low soil moisture content, and extreme climatic fluctuations, however, low protein content may have been the result of decreased availability of N% to the plant because of low soil moisture (Garza, 1994). Kutiel and Lavee, (1999), found that along a climatic transect, the most significant differences in soil and vegetation properties exist between North – facing slopes and South – facing slopes in the Mediterranean zone. That is the main cause of high OM% content in North-facing aspects which mainly come from vegetation and the decomposing factors, which interact with climatic conditions that affected the quantity of organic matter and soil nutrients which affect the chemical composition of plants (Mohammad, A. 2008b). The low organic matter content in the soils is contributed to land degradation through loss of soil fertility and productivity, soil organic matter is an important soil quality, which provides nutrients for plant growth which influences all soil properties (Carmel and Kadmon, 1999; Fu, et al., 2003; Fu, et al., 2004; Rezaei, et al., 2005;).

b-Altitude

Altitude and topography gradient created unique variation with variable ecosystems that have considerable impact on vegetation composition and distribution. It has a significant effect on biomass production, fiber properties, and chemical composition of plants (Corona, et al., 1998). Aldana et al., (2000), found that dry matter production was higher in the lower slope zones than in the upper ones and the influence of topographic position on biomass production has been shown and is related to differences in soil fertility between slope zones. Aldana et al., (2000) also found that grasses, legumes and forbs had higher crude protein contents on the lower than on the upper slope zone. This results agree with Al-Seikh (2006), who showed that available nitrogen (NH_4^+, NO_3^-) were higher in down slope compared to up slope and the changes of soil quality due to leaching of nutrients from up slope and eroded down by runoff water. These differences in crude protein content have been related to differences in soil characteristics and to differences in phenological stages (Corona, et al., 1998; Aldana, et al., 2000). The lower zones have better growth conditions, and plants in these zones are maintained for a longer growing period given that the crude protein content declines with stage of maturation. It is possible that the greater crude protein content in the lower zone partly reflects a later maturation stage of plant species. According to Mountousis, et al., (2006b), they showed that the CP content decreased as the growing season progressed in both altitudinal zones, they approved that the altitude influenced the crude protein content. Mean ash content was found to be 7.91 % and 8.48 % of DM in the lower and upper altitudinal zone, respectively. Also, month-to-month of P concentration was quite variable among different altitudinal zones. An average P value was found to be 0.233 % and 0.236 % of DM in the lower and upper altitudinal zone respectively (Mountousis, et al., 2006b).

1.4.4.2 Soil characteristics

Soil degradation is the most serious manifestation of decline in range condition. Soil is the primary factor that determines the potential for forage production of a specific area, and also soil type affected several nutrients in plants (Wilson and Typper, 1982; Holechek, et al., 1989; Grings, et al., 1996; Rezaei, et al., 2005;). Nutrients, structure and texture of soil largely depends on underlying geology, and influence the biomass production and quality of grazable material of pasturelands (Mountousis et al., 2006a). The quality of grazable material is of great significance to animal production as nutrition is an important factor to the cost of feeding of ruminant animals. Quality is the parameter that includes the concentration of the partial nourishing constituents (chemical composition), the biomass quantity that is consumed (food intake), the digestibility and the segregation of metabolism products of the animals (Mountousis et al., 2006a).

1.4.4.3 Climate

Climatic factors have considerable rule in forming all aspects of plant growth and development (Arnon, 1992). Each climatic factor has a range of optimum intensity which differs between and within species at different growth stages, and plant development is adversely affected, either by excess or deficiency of the intensity of each factor involved (Al-joaba, 2006). The resulting stress may cause physical, biochemical and / or chemical changes (Arnon, 1992). Precipitation is the most limiting climatic factor in dry areas and it determine the soil moisture availability, by the increase of precipitation the organic matter increase which provides nutrients for plant growth with its impact on chemical composition of forages (Evitayani, et al., 2005; Rezaei, et al., 2005). Also shrub N content fluctuations in forage yield are due to changes in available soil nitrogen and differing soil water availability (Ibrahim, 1981; Angell, 1990; Grings, et al., 1996). Aldana, et al., (2000), found that there is higher content of crude protein for rangeland shrubs during the humid period than dry period.

Chapter Two

2- Materials and Methods

2.1 Study sites

The study was conducted at two sites in Hebron district: BaniNoem and Sureif.

2.1.1 BaniNoem Site

Located in eastern slopes of the West Bank, (15) Km east of Hebron city (Al-Seikh, 2006). The geographical position is 35.1 E and 31.4 N. Its topography is mountainous with elevation ranges from 596 to 704 m above sea level. It climatic conditions are Mediterranean semi-arid type. It is in the rain shadow, with average rainfall 250-300 mm, most of it fall with high intensity in short time (MOA, 2004). The soil bedrock is calcareous (limestone or hard chalk) with shallow soil, the soil association in this site is belong to Brown Rendzina and Pale Rendzina (Dan, 1970; Awadallah and Owaiwi, 2005; Al-Seikh, 2006). The site used for many years as rangelands, grazing was excluded by fencing since 1995. The site is characterized by thin vegetation cover and low productivity due to overgrazing which lead to soil erosion and land degradation (Mohammad, 2005; Al-joaba, 2006; Al-Seikh, 2006). For more detailed soil analysis, refer to Al-Seikh, (2006).

2.1.2 Sureif Site

Sureif site is located at the western parts of the central mountain region of the West Bank, (10) Km North West of Hebron city. The geographical position is 35.1 E and 31.6 N (GIS unit, ARIJ, 2001). Its topography is mountainous with steep slopes, its elevation ranges from 568 to 727 m above sea level (Al-Seikh, 2006). The area is considered as semi-humid Mediterranean climate with a long, hot dry summer and short cool rainy winter (ARIJ, 2003). Average annual rainfall is about 400-500 mm/year (ARIJ, 2003). Soil is classified as Terrarossa, Brown Rendzina and Pale Rendzina that contain a relatively large amount of clay (50%), $CaCO_3$ range generally between 10 to 40%, and moderate amount of organic matter (6%) (Awadallah and Owaiwi, 2005). This soil derived from hard limestone and dolomites of upper Cretaceous and Eocene formation (Zohary, 1947; Awadallah and Owaiwi, 2005; Al-Seikh, 2006), for more detailed soil analysis, refer to Al-Seikh, (2006). The area was subject to overgrazing and cutting the trees since the British occupation. The site was fenced and grazing was excluded since 2001. The forest (*Pinus halepensis*) is part of the area which planted in 1960.

2.2 Species Under Investigation

Palestinian rangelands are rich in many indigenous native species; most of them are adapted for arid environment like: *Acacia spp*, *Artemisia spp, Prosopis spp*, and *Platanus spp* (MOPIC, 2000; Mohammed, 2005). According to Mohammed, (2005), the unpalatable species such as: *Sarcopoterium spinosum*, *Asphodelus aestivus*, *Echinops polyceras*, *Eryngium creticum*, and *Thymelaea hirsute* are dominant species in the rangeland at the southern parts of Eastern Slopes in West Bank. This may be due to heavy and selective grazing on palatable species such as *Medicago spp*, *Bromus spp*, *Hordeum spp*, *Aegilops spp*, *Poa bulbosa* and *Avena sterilis*. These palatable species can be considered as decreasers, and it was noticed that some of these palatable species colonize in specific microhabitats especially under shrubs as *Sarcopoterium spinosum* in grazing plots (Salama & Al-joaba, 2008). Also, Pearse, (1970) and Noy-Meir, et al. (1989), reported that the steppic and sub-steppic vegetation in the Middle East has changed from a mixture of palatable grasses, legumes, and other good forage plants to low value annuals, thistles, and worthless weeds, due to uncontrolled grazing (Salama & Al-joaba, 2008). The under investigation species were selected according to Mohammed, (2005) and AL-joaba,

(2006) results, since they identified them as dominant range land plants at the southern parts of Eastern Slopes in West Bank. In addition, the under investigation species were selected due to; information obtained from local skilled farmers. The favorable characters of the species include its native species, high palatability, ease of establishment, wide environmental tolerance, fast growth rate and ability to produce large quantities of biomass, and its wide utilization as forage in some regions (George, et al. 2007). These species were classified into tow groups;

2.2.1 Herbaceous Plants

The herbaceous vegetation appears shortly after the first rains and grow only for two to five months depending on the amount and distribution of rainfall and then dry out during summer (MOPIC, 2000; Mohammed, 2005), tow groups of herbaceous plant were classified:

2.2.1.1 Grasses

Are distinguished by having hollow, jointed stems, fine narrow leaves with large parallel veins and fibrous root system (Holechek, et. al., 1989). According to Mohammed, (2005) and AL-joaba, (2006), two species of grass plants identified as dominant plants these are:

first: ***Avena sterilis*** (L) (wild red oat) (Figure1), a tall annual grass from grameneae family, from 40-80 cm height, flowering in April – June, it is recorded as highly palatable for livestock, widely grown as a fodder in temperate and sub-tropical countries. The green plant is good forage and makes good hay and silage, the straw is useful roughage (Juneidy, 1994; Suttie, 2000).

Figure 1: *Avena sterilis*. Source: GIS Unit (2008). Hebron University. Data Base.

Second: ***Poa bulbosa*** L. (bulbous meadow grass) (Figure 2), perennial plant with a short lifetime, grameneae family, hairless, stems erect or ascendant and in this case often rooted on the nodes, 20 – 100 cm height, wide climate range, tolerates shade. According to Mohammed, (2005) and Al-joaba (2006), *P. bulbosa* is dominant species in the Palestinian rangeland. These palatable species can be considered as decreaser, this may be due to heavy and selective grazing on palatable species.

Figure **2**: *Poa bulbosa*. Source: GIS Unit (2008). Hebron University. Data Base.

2.2.1.2 Forbs

Are broad leaves with netlike veins, and solid non jointed stems. Three species of forbs were identified as dominant according to Mohammed, (2005) and AL-joaba, (2006).

First: *Pisium syriacum* (Figure 3), Leguminosae family, annual with angular or roundish hollow stem, 20-30 cm height, erect and moderately branched stems, leaves 6-10 cm long. Flowered in February – April, leafy types, leaves consist of one or more pairs of opposite leaflets on petioles together with several pairs of tendrils and a single or compound terminal tendril. Flower color differs according to cultivar with white, pink, lavender, blue and purple petals. Pods containing several seeds, high nutritive value, protein-rich, high forage yield in relatively short growth period, highly acceptable feed for different classes of stock (Frame, 1985b).

Figure **3**: *Pisium syriacum*. Source: GIS Unit (2008). Hebron University. Data Base.

Second: ***Medicago rotata*** Boiss. Var. *rotata*, *Genus*: Medicago L. (Figure 4), Fabaceae family. It is annual, hairy plant, 15-30 cm height, stems usually ascending, branching from near base, not climbing. The leaves are stipulate, nearly always alternate, and range from bipinnately or palmately compound to simple, flower 6-8 mm, flowering time between March-May. The fruit is usually a legume, the seeds often have a hard coat with hourglass-shaped cells, they comprise one of the largest families of flowering plants at Jordan valley (Zohary, 1966). Native to Middle East, Cyprus, Palestine , Jordan, Lebanon, Syria, Turkey in Asia and Africa (Zohary, 1966; Clement & Foster, 1994).

Figure 4: *Medicago rotata*. Source: GIS Unit (2008). Hebron University. Data Base.

Third: ***Scorpiurus muricatus*** L. (Caterpillar plant) (Figure 5)

Fabaceae family , it is an annual leguminous plant native to southern Europe and Mediterranean territory with tiny pea-like flowers and simple leaves with plant height 10-30 cm. Plant slightly hairy, stem ascending or erect. Leaves broadly obviate, flowers yellow 2-4 on peduncles at first shorter than the leaf and later exceeding it. Fruits are glabrous pods, strongly furrowed, twisted in a spiral, all lying in the same plane with inner smooth ribs. It can grow in semi-shade (light woodland) or no shade; it grows well in dry or moist soil (Hedrick, 1972; Polunin and Huxley, 1987)**.**

Figure 5: *Scorpiurus muricatus*. Source: GIS Unit (2008). Hebron University. Data Base.

2.2.1.3 Shrubs

Have woody stems that branch near the base and long, course root, (Holechek, et. al.. 1989). Four shrubs species were investigated:

First: ***Acacia cyanophylla*** Lindl (Figure 6), Mimosaceae family, is a bush or small tree native to south-western Australia and in the Mediterranean and North Africa region it is used extensively as a source of fodder for sheep and goats. The favorable characters of the species include its ease of establishment, wide environmental tolerance, fast growth rate and ability to produce large quantities of biomass (George, et al. 2007). Despite these favorable agronomic characteristics and its wide utilization as forage in some regions, however, the reported feed quality of *A. cyanophylla* varies between studies, which have led to the suggestion that different accessions of the species may have different fodder quality groups (George, et al., 2006; George, et al., 2007).

Figure 6: *Acacia cyanophylla*. Source: GIS Unit (2008). Hebron University. Data Base.

Second: ***Atriplex halimus*** **(**Figure 7**),** chenopodiaceae family

It is originated from Australia and had spread to arid and semi arid parts of the world. It is an erect shrub, grows up to 2 m height and spreads to 2.4 m wide, has white branches (Aganga, et al. 2003). It has vascular hairs, whitish leaves alternate, some times opposite bellow, silvery-white, seeds 1-2 mm diameter, lenticular dark brown flowering. It grown as fodder plant in dry areas because of its great resistance to drought and salt (Aganga, et al. 2003). It grows well in deep soils with only 150-200 mm of rainfall annually, but can survive for a year with 50 mm of rainfall, it resists temperatures as low as ¯10 C° (Aganga, et al. 2003). Suitable habitat in saline, wadi beds, sandy soil, Palestine plain, mountain, Dead Sea area, and eastern slops (Zohary, 1966). *A. halimus* constitute an excellent choice as vegetable material for several reasons. The species is a xerohalophyte, perennial, native of the arid and semi arid Mediterranean areas (Abbad, et al. 2004). In addition, it presents a very satisfactory appetability and palatability constituting an appreciated fodder of camels, sheep and goats particularly during the dry period. Endowed with a complex root system and considerable air biomass, it represents for the livestock an important source of minerals, vitamins and proteins (Abbad, et al. 2004). However, *A. halimus* is characterized by high polymorphism due to its large ecological amplitude this situation leads to heterogeneous plantations and a high difference in their productivity (Abbad, et al. 2004).

Figure 7: *Atriplex halimus*. Photography by researcher.

Third: ***Retama raetam*** (Forsk) (white broom) (Figure 8), fabaceae family, endemic to North Africa, the Middle East (Palestine , Jordan, and Lebanon), silky hair, poorly branching, yellowish green, stems thick, leaves 0.2-0.5 x 0.3-0.8 cm, seed yellow or brown . *R. raetam* is adapted to survive extreme drought conditions, mainly in deserts, sandy rocky and gravelly ground, Jordan valley and eastern slopes. Its roots go deep into the earth, while the slender branches reduce the amount of surface area exposed to dry desert air. While it does produce very small leaves, they are quickly dropped in order to conserve water. The majority of photosynthesis is carried out by the green photosynthetic stems. Flowering in February- April, (zohary, 1987).

Figure 8: *Retama raetam.* Source: GIS Unit (2008). Hebron University. Data Base.

Fourth: ***Artemisia herba-alba*** (Wormwood) (figure 9), Compositae family, living parts of aerial shoots become very reduced in summer, aromatic, grayish, easily uprooted owing to its superficially ramifed roots. Flowering in September-December, live in loess and grey steppe and desert soils and one of the most common shrubs in the eastern slopes area, it is recorded as high palatable and important as forage grazed by livestock especially by camels (Sincich, 2002).

Figure 9: *Artemisia herba-alba*. Source: GIS Unit (2008). Hebron University. Data Base.

2.3 Sample Collection and Preparation

2.3.1 Shrubs

Samples of current year growth (leaves, light stem, and stem less than 3 mm in diameter) were collected manually by shear from the shrubs resembling the parts grazed by small ruminants. Four samples (replicates) of each species on mid spring and mid summer from BaniNoem site were collected. Fresh weight was recorded. Dry weight were determined by drying samples in the oven at 105°C to constant weight to determine the moisture content (Wathelet, 1999).

2.3.2 Herbaceous Plants

Samples of forbs and grasses from each species in each site (BaniNoem & Sureif) were collected by clipping random plants at ground level (whole plants: leaves, stems, and seeds) during mid spring and mid summer when biomass were left to senescence from 4 niches (replicates) for each herbaceous species (Mcinnis, et al., 1993). Fresh and dry weight recorded (Wathelet, 1999). Samples were ground and stored in sealed jars for chemical analysis (AOAC, 1990). Representative samples from the replicates were prepared for the analysis of ADF and NDF.

2.4 Chemical Analysis

Samples were ground in a Wiley mill, and stored in sealed jars for chemical analysis (AOAC, 1990). Representative samples from the replicates were prepared for the analysis of ADF and NDF. Chemical analysis was conducted on a dry matter basis. Samples were ashed by igniting in muffle furnace at 550C^{o} for 8h according to AOAC (1984). Crude protein (CP) was determined by estimating nitrogen (N) content using Kjeldahl procedure. Percentage of CP obtained by multiplying the nitrogen concentration by 6.25 (NX 6.25), (AOAC, 1990). Crude fiber was estimated according to (AOAC 1990 and Van Soest 1991). Soxhlet extraction procedure used to estimate

Crude fat (CF) (AOAC, 1990). Phosphorus (P) content was determined by the ammonium metavanadate-ammonium molybdate procedure (Barnes, et al. 1990). Using spectrophotometer method, the vandomolibdate reagents produce a stable yellow color with phosphates (Barnes, et al., 1990; EL-Shatnawi & Ereifej, 2001). Potassium (K) and sodium (Na), concentrations were measured colorimetrically by flame photometer (Corona, et al., 1998; Abbad, et al., 2004). Calcium (Ca) and Magnesium (Mg) contents were determined with an atomic absorption spectrophotometer (Unicam, model SP9, UK) using the wet digestion method with a mixture of nitric, sulfuric and perchloric acids.

2.5 Statistical Analyses

A complete randomized design with 4 replicates was used to compare the chemical composition between species and life forms, while standard deviations were used to compare between seasons and sites by using Sigma Stat V 2.0 for windows program.

Chapter Three

3-Result

3.1Chemical Composition

3.1.1 Dry Matter (DM)

In BaniNoem site there is a high significant **($P \leq 0.05$)** difference in DM content between and within species of forbs, grasses, and shrubs during spring season (Table 1). In BaniNoem site during spring *P. bulbosa* (43.9±1.8%), have significantly the highest DM content, and *S. Muricatus* (17.4±0.3%), *P. syriacum* (20.2±0.6%) and *A. halimus* (21.8±0.1%) have significantly the lowest DM content. In summer, DM% for forbs and grasses were increased dramatically and significantly differ from shrub species content with the lowest value for *A. halemus* (39.5±2.3%) and *A. cyanophylla* (39.7±2.4 %).

In Sureif, similar trend was found, a significant difference in DM% between and within species of forbs and grasses through spring with highest value for *P. bulbosa* (42.9±0.3 %), while *P. syriacum* have the lowest content (21.2±1.0 %). During summer, DM% in all species was increased dramatically and it ranges between (95.3±4.7 - 99±0.7 %).

Table (1): Chemical composition of plant species during spring and summer seasons in BaniNoem and Sureif sites (DM-Basis) (2007).

iNoem		Dry matter %		Crude protein %		Crude Fiber%		Ash%		Crude Fat%	
ups	Spp.	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer	spring	summer
bs	*S. muricatum*	17.4±0.3g	97.6±0.6a	16.6±0.5[1]bc[2]	14.2±0.6b	19.1±4.0 c d	15±3.4 e	16.0±1.1a	18.4±1.8a	4.7±0.22ab	1.1±0.5d
	P. syriacum	20.2±0.6f	98±0.8 a	17.0±0.9 ab	18.6±1.8a	15.1 ±4.0d e	23.9±2.0 d	10.3±3.3bcd	9.1±0.9cd	0.8±0.2e	1±0.8d
	M. rotata	28±0.7 de	98.3±0.7a	15.4±0.4 c	14.9±1.6b	11.4±1.5 e	17.8±0.5 e	12.2±1.2b	12.8±1.8b	3.4±1.5bcd	3.4±1.8b
asses	*P. bulbusa*	43.9±1.8a	98.2±1.8a	8.6±0.5 d	6.6±2.9 c	39.9±4.8 a	37.9±2.4 b	7.6±1.7e	10.8±2.3bc	3.1±0.2bcd	2.7±1.4bc
	A. sterilis	26.8±0.8e	99.3±0.6a	9.1±0.6 cd	6±0.7 c	26.9±3.4 b	42.2±3.7ab	7.5±0.8e	11±2.9bc	5.2±0.5a	0.7±0.6d
ubs	*A. cyanophylla*	33.3±2.7c	39.7±2.4d	16.4±0.9 bc	15.3±0.4b	30.3±2.9 b	41.2±5.3ab	11.1±2.2bc	9.9±1.0c	2.1±0.7de	3.1±0.3bc
	A. halimus	21.8±1 f	39.5±2.3d	17.3±0.9 b	15.1±2.2b	19.1±4.7 cd	38±3.7 b	8.7±1.2de	7.2±2.2de	4.4±1.7abc	1.8±0.8cd
	R. raetam	37.9±1.5b	53.3±0.8c	19.7±1.5 a	14.5±0.4b	25.3±5.4 bc	31.9±6.8 c	5.1±0.2f	4.9±0.5e	2.4±1.2de	1.8±0.5cd
	A. herba-alba	29.3±2.1d	64.9±1.6b	16.8±2.2bc	8.8±0.7 c	39.8±7.0 a	45.1±3.8 a	9.5±0.4cde	5.2±0.4e	2.8±1.8cd	5.2±1.1 a
reif site											
rbs	*S. muricatum*	16.1±1.5d	95.3±4.7a	17.0±1.0 b	16.8±1.8b	14.2±3.0 c	24.3±3.9 c	15.4±0.7a	17.9±4a	2.3±0.8bc	1±0.3b
	P. syriacum	21.2±1.0 c	98.5±0.5a	19.5±0.25a	20.5±1a	16.4±3.8 c	22.5±0.4 c	10.7±0.6b	9±0.9b	1.2±0.3c	0.5±0.2b
	M. rotata	27.5±1.5b	98.8±0.2a	16.1±0.9 b	12.7±1.4c	17.4±3.7 c	24.2±4.0 c	10.5±0.5b	15.6±1.7a	3.2±0.6b	3.8±1.3a
asses	*P. bulbusa*	42.9±0.3a	97.1±3.5a	7.6±0.5 d	6.6±1.3 d	38.2±4.7 a	43.7±6.0 a	5.6±1.7d	11.4±1.1b	1.7±0.4c	3.7±1.6a
	A. sterilis	22.6±1.6c	99±0.7 a	12.1±0.4 c	5.5±0.6 d	31.4±5.7 b	35.8±5.2 b	7.6±1.2c	8.7±1.3b	5.9±1.5a	1.3±0.3b

1- Standard deviation

2-Means in the same column and at the same site followed with different letters are significantly different according to Fisher LSD test at P ≤ 0.05

3.1.2 Crude Protein

Crude protein content was significantly ($P \leq 0.05$) different according to both site and season (Table 1). CP value In forbs and shrubs in spring had higher values (15.4±0.4 -19.7±1.5 %) compared to grasses (8.6±0.5 - 9.1±0.6%). In spring, R. raetam and P. syriacum have significantly the highest CP content (19.7- 19.5%) respectively, compared with other species, while P. bulbusa and A. sterilis, in both sites, have the lowest content. In summer, the CP content either stays the same compared to spring season or showed a decreasing trend in others, except for A. herba-alba and A. sterilis that showed a drastic decrease during summer season. Shrubs and forbs, except for A. herba-alba, had significantly higher CP content during summer than grasses which range between (12.7±1.4 - 20.5±1.0%) for forbs and shrubs and (6±0.7- 6.6±2.9%) for grasses. P. syriacum have significantly ($P \leq 0.05$) the highest CP content (18.6±1.8 – 20.5±1.0%) compared to other species in both sites respectively. During summer season, CP % tends to be higher in Sureif compared to BaniNoem site.

3.1.3 Ash Content

There is highly significant difference in ash content between and within species of forbs, grasses, and shrubs in both seasons and sites (Table 1). During spring season, grasses have significantly **($P \leq 0.05$)** lower ash content than forbs and most shrub species (Table 1). Data showed that *S. Muricatus* have significantly the highest ash content at both sites and *R. raetam*, *P. bulbosa*, and *A. sterilis* have the lowest ash content. In summer season, ash content of forbs and grasses showed an increasing trend compared with spring season. That range between (9.1±0.9 to 18.4±1.8%), except for *S.*

Muricatus were slightly increased, while shrubs ash content were slightly decreased and ranged between (4.9±0.5- 9.9±1.0%).

3.1.4 Crude Fat

Results showed a high and significant (P ≤ 0.05) variability in crude fat between grasses, shrubs and forbs species. The differences between species were highly significant in the tow sites and during spring and summer seasons (Table 1). In both sites during the spring season, *A. sterilis* have the highest C. fat % (5.2±0.5 and 5.9±1.5%), and it is significantly different from other species except *S. muricatum* (4.7±0.22%) and *A. halimus* (4.4± 1.7%) (Table1). *P. syriacum*, *A. cyanophylla,* and *R. raetam* in BaniNoem site and *P. syriacum* and *P. bulbusa* in Sureif site have very low C. fat % content during spring season.

In general, crude fat content in most species were decreased during summer season except for *A. herba-alba* and *P. bulbusa* (in Sureif site) showed an increase in crude fat percentage. In BaniNoem site, during summer season *A. herba-alba* significantly **(P ≤ 0.05)** had higher crude fat content (5.2±1.1%) than other species, followed by *M. rotata* (3.4±1.8%), *P. bulbusa* (2.7±1.4 %), and *A. cyanophylla* (3.1±0.3 %). In Sureif during the dry season C. fat content of *S. Muricatus* (1±0.3%), *P. syriacum* (0.5±0.2%) and *A. sterilis* (1.3±0.3%) were decreased.

3.1.5 Crude Fiber

The difference in crude fiber content between shrubs, forbs, and grasses were highly significant in BaniNoem and Sureif sites during both seasons (Table 1). In general, data showed that forbs have lower crude fiber than grasses and shrubs during both spring and summer seasons. *M. rotata* at

BaniNoem site have the lowest crude fiber (11.4±1.5%) in both seasons and it significantly **(P ≤ 0.05)** different from other species except from *P. syriacum* and *S. Muricatus*. On the other hand, *P. bulbosa*, and *A. herba-alba* have the highest crude fiber content (45.1±3.8 and 43.7±6.0%), during both seasons. In summer all species crude fiber content were increased compared to spring season, forbs have lower crude fiber content than grasses and shrubs in both seasons.

3.1.5.1. Neutral detergent fiber (NDF) percentage

Neutral detergent fiber content of grasses was higher than shrubs and forbs in both sites and seasons (Table 2). In BaniNoem during spring season the content of NDF ranged between (58.8-70.9%), (38.8- 50.2%), and (45.1-50.3%) for grasses, shrubs, and forbs, respectively. *P. bulbosa* have the highest NDF content (70.9 %) while *A. cyanophylla* have the lowest content 38.8% (Table 2). In Sureif, there is no vast difference in NDF % compared to semi arid site (BaniNoem) during spring season, while *P. bulbosa* have the highest NDF content (79.5%), *P. syriacum* and *S. Muricatus* have the lowest NDF content. In BaniNoem during summer, NDF content were tend to increase compared with spring season for *P. bulbosa* and *A. sterilis*, where they showed the highest NDF content (81.1% and 70.6 % respectively). *P. syriacum* showed the lowest content (41%). In Sureif during summer season NDF % ranged between (71.1- 76.6%) and (44.9- 54.8 %) for grasses and forbs, respectively (Table 2).

Table (2): Neutral detergent fiber (NDF) percentage in forbs, grasses, and shrubs species at BaniNoem and Sureif sites during spring and summer seasons (DM- Basis) (2007).

		BaniNoem		Sureif	
groups	spp	spring	summer	spring	summer
Forbs	*S. Muricatus*	45,1	47,3	43,8	54,8
	M. rotata	50,3	49,9	47,4	53,2
	P. syriacum	50,2	41,0	40,0	44,9
Grasses	*P. bulbosa*	70,9	81,1	79,5	71,1
	A. sterilis	58,8	70,6	58,5	76,6
Shrubs	*A. halemus*	46,4	49,6		
	A. cyanophylla	38,8	48,2		
	A. herba-alba	50,2	54,6		
	R. raetam	47,8	50,0		

3.1.5.2 Acid detergent fiber (ADF) percentage

Acid detergent fiber tend to be the highest in grass followed by shrubs, except *A. halemus*, and the lowest in forbs at both sites and during spring and summer seasons (Table 3). In BaniNoem site, during spring season the content of ADF ranged between (40.8-50.0%), (21.5- 47.2%), and (32.3-37.1%) for grasses, shrubs, and forbs, respectively (Table3). In Sureif site, there is no large difference in ADF % compared to BaniNoem site during both seasons. In Sureif site, during spring season *A. sterilis* have the highest ADF content (51%), where *S. Muricatus* have the lowest content (27.5%). In summer, all species ADF percentage were increased except for *P. syriacum* were decreased, *A. sterilis* have the highest ADF content (63.8%), but the lowest content were for *P. syriacum* (32.8%).

Table (3): Acid Detergent Fiber (ADF) percentage in forbs, grasses, and shrubs species at BaniNoem and Sureif sites during spring and summer seasons (DM-Basis) (2007).

		BaniNoem site		Sureif site	
groups	**spp**	**spring**	**summer**	**spring**	**summer**
Forbs	*S. Muricatus*	32,3	29,3	27,5	33,4
	M. rotata	37,1	36,0	36,0	39,4
	P. syriacum	33,4	31,6	34,4	32,8
Grasses	*P. bulbosa*	40,8	56,9	43,3	58,1
	A. sterilis	50,0	67,6	51,0	63,8
Shrubs	*A. halemus*	21,5	30,3		
	A. cyanophylla	38,3	44,4		
	A. herba-alba	47,2	38,4		
	R. raetam	38,4	33,4		

3.1.6. Mineral contents

3.1.6.1. Sodium (Na) percentage

In semi arid site during spring season, species have significant ($P \leq 0.05$) difference in the percentage of Na. It varied among and between the species of forbs, grasses, and shrubs and it ranged between (0.01±0.001- 1.04±0.12%) (Table 4). At BaniNoem in both seasons, *A. halemus* recorded significantly ($P \leq 0.05$) the highest Na content (1.04±0.12 and 0.87±0.1%), respectively, while *P. bulbusa* had the lowest Na percentage (0.01±0.001 and 0.05±0.04%), respectively. In Sureif site during spring season, percentage of Na were varied among the species of forbs, and grasses, and ranged between (0.02±0.02- 0.25±0.1%). *S. Muricatum* and *A. sterilis* have significantly the highest Na content. During summer season, at Sureif, Na percentage ranged between (0.01±0.001- 0.23±0.04%). *A. sterilis* have the highest Na content, followed by *S. Muricatum*.

Table (4): percentage of mineral content of several forbs, grasses, and shrubs species at BaniNoem and Sureif sites during spring and summer seasons (DM-Basis) (2007).

BaniNoem site		Na%		Mg%		P%		Ca%		K%		N%	
Groups	Spp	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer	spring	summer	spring	summer
Forbs	*S. Muricatus*	0.22±[1]0.1[2]bc	0.15±0.02bc	0.41±0.16b	0.3±0.06b	0.01±0.001b	0.01±0.001b	1.5±0.1b	1.4±0.15a	0.9±0.15ab	0.6±0.03ab	2.7±0.15bc	2.3±0.09b
	P. syriacum	0.1±0.08de	006±0.01d	0.21±0.05def	0.19±0.04c	0.01±0.001b	0.02±0.001a	0.8±0.06c	0.8±0.04cd	0.6±0.1c	0.5±0.04b	2.7±1.5bc	3±0.29a
	M. rotata	0.05±0.04de	0.07±0.04d	0.35±0.04bc	0.4±0.06a	0.01±0.005b	0.02±.005a	1.5±0.4b	1.2±0.3ab	0.8±0.05bc	0.8±0.09a	2.5±0.06c	2.4±0.25b
Grasses	*P. bulbusa*	0.01±0.001e	0.05±0.04d	0.17±0.02ef	0.3±0.1b	0.02±0.002a	0.01±.005b	0.7±0.01cd	0.3±0.12f	0.4±0.006d	0.6±0.15ab	1.4±0.07d	1.6±0.46cd
	A. sterilis	0.14±0.09cd	0.22±0.02b	0.12±0.01f	0.25±0.07bc	0.01±0.005b	0.01±0.001b	0.5±0.17de	0.6±0.4de	0.7±0.3c	0.6±0.07ab	1.5±0.1d	1±0.1d
Shrubs	*A .cyanophylla*	0.08±0.02de	0.07±0.02d	0.28±0.1cde	0.22±0.05bc	0.01±0.001b	0.01±0.001b	1.8±0.4a	1±0.2bc	0.3±0.1d	0.3±0.07c	2.6±0.14bc	2.4±0.06b
	A. halemus	1.04±0.12a	0.87±0.1a	0.57±0.09a	0.41±0.04a	0.01±0.005b	0.01±0.001b	1.3±0.18b	0.4±0.25ef	1±0.1a	0.8±0.2a	2.8±0.14b	2.4±0.35b
	R. raetam	0.06±0.03de	0.06±0.02d	0.25±0.03cde	0.25±0.04bc	0.01±0.005b	0.01±0.001b	0.3±0.06e	0.7±0.08cde	0.4±0.09d	0.2±0.05c	3.15±0.24a	2.3±0.06b
	A. herba-alba	0.29±0.02b	0.13±0.07c	0.30±0.05bcd	0.23±0.09bc	0.01±0.001b	0.01±0.001b	0.2±0.03e	0.4±0.2ef	1.1±0.1a	0.4±0.1c	2.7±0.3bc	1.4±0.12c
Sureif site													
Forbs	*S. Muricatus*	0.25±0.10a	0.13±0.07b	0.32±0.1b	0.25±0.05bc	0.01±0.001b	0.01±0.001b	1.4±0.17a	1.4±0.17a	1±0.1a	0.6±0.03b	2.7±0.17b	2.7±0.29b
	P. syriacum	0.06±0.05b	0.07±.005bc	0.32±0.04b	0.22±0.03c	0.02±.005a	0.01±.005b	1.4±0.2a	1.15±0.11b	0.9±0.1ab	0.6±0.02b	3.1±0.04a	3.3±0.17a
	M. rotata	0.09±0.03b	0.09±0.03b	0.50±0.1a	0.49±0.06a	0.01±0.001b	0.01±.005b	1.6±0.17a	1.2±0.12ab	1±0.2a	0.8±0.03a	2.6±0.15b	2±0.0.2c
Grasses	*P. bulbusa*	0.02±0.02b	0.01±0.0c	0.13±0.01c	0.32±0.07b	0.02±0.001a	0.01±0.001b	0.6±0.03b	0.5±0.25c	0.4±0.005c	0.6±0.1b	1.2±0.08d	1±0.2d
	A. sterilis	0.20±0.06a	0.23±0.04a	0.27±0.05b	0.18±0.06c	0.02±.005a	0.01±.005b	0.6±0.1b	0.4±0.18c	0.9±0.04b	0.6±0.09b	1.9±0.06c	0.9±0.09d

1- **Standard deviation**

2-Means in the same column and at the same site followed with different letters are significantly different according to Fisher LSD test at $P \leq 0.05$.

3.1.6.2. Magnesium (Mg) Percentage

There is a significant ($P \leq 0.05$) difference in Mg content between species of forbs, grasses and shrubs at both sites during spring and summer seasons (Table 4). During the spring, forbs and shrub species have higher content of Mg than grasses which ranged between (0.21±0.05 and 0.57±0.09 %) and (0.12±0.01 to 0.17±0.02%), respectively. *A. halemus* have significantly the highest Mg content but *P. bulbusa* and *A. sterilis* were the lowest. Forbs and shrubs Mg content tended to decrease during summer, except for *M. rotata*, on the contrary, grasses were tend to increase. *A. halemus* and *M. rotata* remain the highest in Mg % during summer that ranged between (0.41±0.04-0.4±0.06%), respectively. At Sureif site during spring season, *M. rotata* have significantly the highest Mg content (0.5 %), and *P. bulbusa* were the lowest (0.13 %). Forbs and grasses Mg content tend to decrease during summer except *P. bulbusa*.

3.1.6.3 Phosphorus (P) Percentage

Phosphorus percentage were very low at both sites during spring and summer seasons and it ranged between (0.01±0.001– 0.02±.005%),(Table 4). There is no significant difference in P content between species of forbs and shrubs in BaniNoem during spring, *P. bulbusa* have significantly the highest P content compared with other species (Table 4). In Sureif, during spring, grasses have significantly higher P % than forbs except for *P. syriacum*. In both sites during summer, all species P % were (0.01 %) except for *P. syriacum* and *M. rotata* at BaniNoem site. Shrub P % was stable and no change has been observed between seasons.

3.1.6.4 Calcium (Ca) Percentage

There is a significant difference in Ca % content between species of forbs, grasses, and shrubs in both sites during spring and summer seasons (Table 4). In BaniNoem site during spring season, Ca content ranged between (0.8±0.06 – 1.5±0.4), (0.5±0.17 – 0.7±0.01), and (0.2±0.03 – 1.8±0.4) for forbs, grasses, and shrubs, respectively, and generally forbs have higher Ca content than grasses. *A. cyanophylla* have significantly the highest Ca content (1.8 %), *A. herba-alba* (0.2±0.03%) and *R. raetam* (0.3±0.06%) have significantly the lowest Ca content. In summer, at the same site, percentage of Ca ranged between (0.8±0.04 – 1.4±0.15), (0.3±0.12 – 0.6±0.4), and (0.4±0.2 – 1.0±0.2) for forbs, grasses, and shrubs, respectively. *S. Muricatus* and *M. rotata* have significantly the highest content. At Sureif, the trend for Ca content was similar to that at BaniNoem (Table 4). During spring, Ca content range between (1.4±0.17 – 1.6±0.17) for forbs and it is significantly higher than that at grasses (0.6±0.1 – 0.6±0.03). During summer, Ca content was also significantly higher in forbs than grasses.

3.1.6.5 Potassium (K) Percentage

At BaniNoem site, K content was significantly different ($P \leq 0.05$) among species and between summer and spring seasons (Table 4). At BaniNoem site during spring season K content ranged between (0.6±0.1 – 0.9±0.15), (0.4±0.006 – 0.7±0.3) and (0.3±0.1- 1.1±0.1) for forbs, grasses, and shrubs, respectively. *A. halemus* and *A. herba-alba* have significantly the highest K content, while *P. bulbusa* and *A. sterilis* have the lowest percentage. During summer at the same site, the percentage of K ranged between (0.5±0.04- 0.8±0.09), (0.6±0.07 – 0.6±0.15), and (0.2±0.05- 0.8±0.2) for forbs, grasses, and shrubs, respectively. *M. rotata* and *A. halemus* have significantly the highest K content. At Sureif site the percentage of K have similar trend to that in BaniNoem. K content ranged between (0.9±0.1- 1±0.2) and

(0.4±0.005- 0.9±0.04) for forbs and grasses, respectively, during spring. The percentage were decreased through summer except for *P. bulbusa* and ranged between (0.6±0.02- 0.8±0.03%) and (0.6±0.1- 0.6±0.09 %) for forbs and grasses, respectively.

3.1.6.6 Nitrogen (N) Percentage

At BaniNoem site there is high significant difference in N content among species during spring and summer seasons (Table 4). In spring, forbs and shrubs have the highest N content compared with grasses which range between (2.5±0.06 - 3.15±0.24 %) and (1.4±0.07 – 1.5±0.1%), respectively. *R. raetam* have significantly the highest N content (3.15±0.24%), while *P. bulbusa* (1.4±0.07 %) and *A. sterilis* (1.5±0.1 %) have significantly the lowest content. During summer season, shrubs and forbs had higher N content than grasses which ranged between (1.4±0.12 – 3.0±0.29%) and (1.0±0.1- 1.6±0.46%), respectively. At Sureif site there is a significant difference between species in N % Content, forbs have significantly higher N % content than grasses during spring and summer seasons. During spring, N% content for forbs and grasses range between (2.6±0.15- 3.1±0.04%) and (1.2±0.08 -1.9±0.06%), respectively, while during summer N percentage tend to decrease except for *P. syriacum* (3.3±0.17 %) have significantly the highest N percentage compared with other species.

Chapter Four

4. Discussion

4.1 Dry Matter Percentage (DM)

Dry matter (DM) percentages during spring, in forbs, grasses, and shrubs were significantly different and ranged between (16.1±1 - 43.9±1.8%) in both sites (Table 1). DM is a descriptive measure of forages, it showed a high increase during dry seasons when species were senescenced and dried (Mcinnis, et al. 1993). The content of DM for grasses and forbs during summer ranged between (97.6±0.6- 99.3±0.6%) which is normal result for dried species due to sampling date, species were dried well during 4-5 months air drying in dry and hot summer (samples collected in august) (Evitayani, et al. 2005). Similar results were found also by Pessarakli, et al., (2005). Shrubs DM% increased in dry season to the average of (39.5±2.3-64.9±1.6%) this increase is relatively low in comparative to forbs and grasses because shrubs remain green in dry season and keep its moisture content (Mcinnis, et al. 1993). Also grasses significantly had higher DM content than forbs during spring than summer, this is due to the higher stem than leave ratios in grasses than forbs (Mcinnis, et al. 1993; Pessarakli, et al., 2005). During spring, BaniNoem species were higher in DM content than Sureif species except for *P. syriacum* this result probably due to early and faster maturation of species in arid site than humid ones (Evitayani, et al. 2005) .

4.2 Crude Protein

Crude protein content is one of the most important forage characteristics for rangeland herbivores. In range plants, CP level are well correlated with many desirable plant components like digestibility (Sullivan, 1962; Ganskopp and Bohnertn, 2001). CP serves as a reliable measure of overall nutritional value (Ganskopp and Bohnertn, 2001). In most of studied species, CP in Sureif site during spring and summer were tend to be higher than species at BaniNoem, this may due to higher soil moisture and organic matter in Sureif which lead to higher N availability and early mature of species at BaniNoem (Ibrahim, 1981; Angell, 1990; Garza, 1994; Evitayani, et al. 2005). In this study forbs and shrubs recorded higher levels of CP content than grasses in both seasons and sites (Table 1). CP content during spring and summer seasons were more than the protein requirements of ruminants except for grasses during summer season (Holechek, et al. 1989; Abbad, et al. 2004). Small ruminant needs 7 to 9% crude protein for maintenance and 10 to 12% for lactation (Ganskopp and Bohnertn, 2001). In dry season, most of species CP content was tend to decline due to maturity and low soil fertility but it still in the ruminants protein requirement range. This decline might be due to the decrease in the availability of N to the plant because of low soil moisture (Angell, 1990; Garza, 1994; Evitayani, et al. 2005; Mountousis, et al. 2006a; Fatur & Abdel Ati, 2007). The feeding value of the grass deteriorates in dry season, CP content declined to less than protein requirements (less than 8%), and the animals feeding forages begin losing weight and so livestock usually require feed supplementation (Nesheiwat and Muhammed, 1987). CP content of forbs was high in spring. It ranged between (15.4±0.4 and 19.5±0.25 %) (Table 1), this range of CP content, is due to the high leaves to stem ratio, therefore, forbs represent a good source of protein for livestock. Also, during dry summer, CP content in forbs still ranged between (14.2±0.6- 20.5±1%), which might be due to increase of seeds and pods ratios than stems and leaves parts (Mcinnis, et al., 1993). These results showed the importance of forbs as high quality forage. CP of shrub species were high in spring and summer and range between (8.8±0.7-19.7±1.5%), indicating the importance of shrubs as a feed supplement for livestock mainly during dry seasons in arid and semiarid rangelands. Our results showed that crude protein contents in shrubs specially which have seeds and pods were sufficient to meet the maintenance and lactation requirements of ruminants throughout the year (Holechek and Herbel, 1986; Msangi and Hardesty, 1993; Garza, 1994; El-Shatnawi and Mohawesh, 2000; EL-Shatnawi & Ereifij, 2001). Results showed a sharp decline in grasses CP percentage during dry period in both sites to levels less than feed requirements, this declines is due to the decrease in leaves to stem ratio, in addition, the plant become dry (Garza, 1994; El-Shatnawi and Ereifij, 2001). There is a negative relationship between CP and fibers relating to growth stage, the species which have high CP content recorded low in fiber content, as the season progressed. Dry matter and components of fibers increased, caused decrease in CP % because of high concentrations of seed heads, and the increase of stems than leaves ratios, where as leaves were higher in CP, stems were higher in crude fiber and cellulose (Mcinnis, et al. 1993; Abbad, et al. 2004). Evitayani, et al. (2005), showed that during dry season, high intensity of solar radiation and lower rainfall caused faster maturation and this result in higher cell wall constituents and lower cell content than in humid season.

CP percentage mainly depend on the N concentration in plant content. Data showed that N % of all species were decreased through time and during dry saesons, this result is due to N % leaching and decomposition, also protien in older leaves and plant parts were hydrolized and its products translocated to other plant parts like roots (Msangi and Hardesty, 1993; Abbad, et al., 2004).

4.3 Ash Content

Ash content of forbs was higher than grasses and shrubs in both seasons and sites (Table 1). Ash content of grasses increased with time and with maturity stage, on the contrary, shrubs and forbs species with seeds were decreased in ash content, this may due to the increase of seeds ratios relatively to other parts this agree with EL-Shatnawi & Ereifij, (2001). This result proved by the negative relation between ash content and CP content trends in the current data, that means when the CP increased with maturity due to increase of seeds and fruits, ash content were decreased. Similar results were found also by (Long, et al. 1999; Ayed, et al. 2001; Aganga, et al. 2003; Gulsen, et al. 2004; kamalak, et al. 2005a; and Mountousis, et al. 2006b).

4.4 Crude Fat

Fat deposits are the main source of stored energy in range animals, (Holechek, et al., 1989). *A. sterilis* have the highest C. fat content followed with *S. Muricatus* and *A. halimus* during the spring season (Table 1), this indicated that green parts have higher chemical composition than dried ones (Holechek, J, et. al. 1989; Corona, et al., 1998; Canan, 2004). Fat content were increased in some species during summer like *A. cyanophylla* and *A. herba-alba*, this is probably due to the high ratio of seeds than stem and leaf parts, vegetable parts of plants relatively lower in fats than seeds and fruits (Holechek, J, et. al., 1989). Therefore, shrub species such as *A. cyanophylla* and *A. herba-alba* which have pods and seeds represent a good source of energy for livestock during dry summers and autumns (Holechek and Herbel, 1986; EL-Shatnawi & Ereifij, 2001).

4.5. Fiber content

4.5.1 Crude fiber

The relative increase in crude fiber content in all species (except for *s. Muricatus*) during summer and the difference between species were found (Table 1). The fiber increase accompanied with maturity and as the growing season progressed. Early growth stage plants contain low fiber content. This data agree with the finding of Corona, et al., (1998); Ganskopp & Bohnertn, (2001); Fatur & Abdel Ati, (2007). The present findings showed relatively high level of crude fiber contents for grasses and shrubs compared to forbs, this result is probably due to the increase in stems to leaves ratio. This result agree with the fact that early growth stage of forage plant leaves contain high protein and low fiber content. Species have low fiber content associated with higher digestibility and higher dry matter intake in sheep (Ahamefule, et al. 2006; George, et al. 2007; Towhidi, 2007). No trends were found between sites, some species were higher in C. fiber in BaniNoem while others were higher in Sureif site. This level of fiber (11.4±1.5 - 45.1±3.8) (Table 1) in the under investigation species were within the range that can providing excellent intake for ruminants which require fiber content around 40% (Robinson, 1999; Leep and Dietz, 2008).

4.5.2 ADF percentage

Acid-detergent fiber (ADF) contains cellulose, lignin and cutin. The higher ADF content the less digestible of forage for ruminants (Robinson, 1999; Leep andq Dietz, 2008). Our results (Table 3) indicated that grasses were higher in ADF content than forbs and shrubs in both seasons and sites, because of increase of cell wall than cell content, also grasses have hollow stems, that might contain relatively more fibrous tissues than shrubs and forbs, so grasses have low digestibility and crude protein than forbs and shrubs (El-Shatnawi and Mohawesh. 2000; Canan, 2004;

Guslin, et al. 2004; Kamalak, et al. 2005a). Forbs and shrubs recorded a normal levels of ADF (29.3- 39.4%) and (21.5- 47.2%), respectively (Table 3), within the range of accepted levels for ruminant feed requirements (Robinson, 1999). This result agree with Dong, et al. (2003), who found that ADF content of some shrub species range between (25%- 40 %), but grasses were higher than that recorded (40.8 - 67.6%). Some species recorded an increase in ADF content during summer due to maturity that associated with increase in cell wall content, while other species like forbs which have pods and seeds in summer had low ADF content (Ganskopp and Bohnertn, (2001); Dong, et al. (2003); Garza, (1994); Bal, et al., (2006)).

4.5.3 NDF percentage

Neutral-detergent fiber is made up of four main chemical components (it is ADF + hemicellulose), quantitatively the largest, cellulose and hemicelluloses are potentially digestible, and the other main components of NDF are lignin and cutin (Ahamefule, et al. 2006). NDF content of forage is important measurement because they provide an estimate of digestibility (Ahamefule, et al. 2006). The higher the NDF content of forage relative to ADF content, it increases the level of food intake (Holechek, et al. 1989; Ahamefule, et al. 2006). The level of NDF for forbs and shrubs species which ranged between (40.0-54.8%) and (38.8-54.6%), respectively, (Table 2). In both seasons and sites NDF content were cope with requirements of livestock which is around 40% according to Robinson, (1999) and Leep & Dietz, (2008). Grass species level of NDF ((58.8- 81.1%), were slightly higher than the suitable level of feed requirements (Robinson, 1999; Leep and Dietz, 2008). This indicate that ruminants need large quantities of grass forage than other species to cover its feed requirement (Robinson, 1999; Leep & Dietz, 2008). NDF content were increased through summer, this increase is due to maturity (growth stage) of plants and increase of stem to leave ratios as mentioned by

Dong, et al. (2003); Canan, (2004); El Hadrami, et al. (2004); Distel, et al., (2005). NDF content of *P. syriacum* was decreased in semi arid site through summer this result is probably due to the increase of pods and seeds to stem and leaves ratio. During spring season, NDF content of species in BaniNoem site were higher than the species of Sureif site during the same time except for *P. bulbusa*, this result probably due to early maturation of species in semi arid site than semi humid ones (Evitayani, et al. 2005; Pessarakli, et al., 2005).

4.6. Minerals/ Macronutrients

Growth depends upon C, H, O, and at least 13 mineral elements, six of these (N, P, K, Ca, Mg, and Na) are macro-elements that normally occur in plants at concentrations greater than 1,000 mg kg-1 level (Masters, et al. 2005). The remaining micro elements (B, Cu, Fe, Mn, Mo, and Zn) normally occur in plants at concentrations less than 50 mg kg-1 (Masters, et al. 2005). Minerals are the chemical elements required by living organisms, the total mineral content of animal's body is usually less than 5% (Holechek, et al. 1989; Ganskopp and Bohnertn, 2001; Masters, et al. 2005). Minerals serve many essential functions in the animal's body. Mineral deficiencies and imbalances are reflected in poor animal condition and productivity, and increased death losses. Some of minerals which have been studied (N, P, K, Ca, Mg and Na) were present in amounts within the range or greater than required, but others, were lower than feeds requirement of livestock (NRC, 1984 and 1985; Mayland and Shewmaker, 2001). In this study concentrations of N, K, Ca, Na, Mg, were varied among seasons and within forage classes (Table 4). The cause of seasons fluctuations come from that different parts of plant have different concentrations of minerals (Barnes, et al. 1990; Mcinnis, et al. 1993; Corona, et al., 1998) as showed below:

4.6.1. Sodium (Na %)

Among the sites and the plant life form we found that the percentage of Na are slightly different (Table 4) and the Na percentage tend to decrease during summer. Recommended level of Na content in the forage for livestock, according to (NRC, 1984; Mayland and Shewmaker, 2001), is 0.08 – 0.2%, especially through dry period. Some species like *P. bulbusa*, *M. rotata*, *R. raetam*, *P. syriacum*, and *A. cyanophylla,* have low levels of Na % indicating the need for a continuous supply of salt to livestock grazing this type of vegetation. *A. halimus* which is halophytic species have the highest concentration of Na % that range between (1.04±0.12 – 0.87±0.1 %) during humid and dry season, and it is more than the recommended levels for livestock (Rumbaugh, et al. 1993; Grings, et al., 1996). *A. halimus* is a fodder plant grown in dry areas and have great resistance to drought and soils as well as water salinity. The increase of consumption of *Atriplex* spp, is accompanied by higher water intake because of increase in water required for urinary excretion of sodium (Aganga, et al. 2003). The low level of Na in herbaceous plants (forbs and grasses) and the high level in *Atriplex* spp indicate the importance of having mixed diets in the rangeland. Similar conclusion was found by Aganga, et al. (2003), who stated that to minimize the adverse effects due to high minerals content of halophyte tissues is by providing mixed forage. During spring, Na % at Sureif site were higher than species of BaniNoem except for *P. syriacum* this result due to increase of precipitation in Sureif than BaniNoem site that associated with the increase of OM% (Al-Seikh, 2006) and so more availability of minerals than arid sites.

4.6.2. Magnesium (Mg %)

Table (4) shows that Mg content around the levels of livestock requirements (NRC, 1984; Mayland and Shewmaker, 2001). Forbs and shrubs Mg contents were tending to decrease during summer. on the contrary grasses were tend to increase. These results agree with Rumbaugh, et al. 1993, who found that grasses Mg concentrations increased with maturity through out the growing season because of increase of stems than leaves ratios in grasses since the stems have higher Mg content than leaves (Rumbaugh, et al. 1993). While in forbs and shrubs Mg content were decreased. No trends were found in Mg content between sites.

4.6.3. Phosphorus (P %)

Phosphorus content of all studied species were very low at both sites and seasons and it ranged between (0.01 – 0.02 %), (Table 4). These values were below the requirement of livestock (NRC 1984; Mayland and Shewmaker, 2001). During summer season, the P percentage was declined due to plants growth. Most studies finding caused the low concentrations of P % to drought especially in arid and semi arid sites because of the leaching among plant parts and soil runoff and low content of P in soils (Holechek, et al. 1989; Islam and Adams, 2000). Forage may lose up to 52% of P during dry seasons (El-Shatnawi and Ereifij, 2001). In addition, leaves had relatively higher content of P than stems, however, after senescing during dry season stems were higher than leaves ratios (El-Shatnawi and Mohawesh, 2001). Arid and desert land range forages often contain high levels of Ca in relation to P (Holechek, et al. 1989), Ca/P ratios of 1/1 to 2/1 considered optimal, but in many arid areas this ratio is much higher (Holechek, et al. 1989). Ruminant exhibit considerable tolerance to high Ca/P ratios, several studies showed that ratios of Ca/P 1/1 to 7/1 have given satisfactory. Our data showed that Ca/P ratios were higher than optimum levels, so P supplementation may be necessary to meet the animal requirements (NRC, 1984; Mayland and Shewmaker, 2001).

4.6.4. Calcium (Ca %)

Calcium percentages in the conducted species were around the normal levels (0.3-0.4 %) of forage for livestock feeds requirements (NRC, 1984; Mayland and Shewmaker, 2001). During summer, some species recorded slight decline because of heavy leaching or soil type and its content of Ca (Holechek, et. al., 1989). Other species remain constant or increased. The ratio of Ca: P in this study is higher than optimum level of 2:1 required for the effective utilization of those minerals in forage, so the supply of P to livestock is effective for the utilization of minerals (Rumbaugh, et al. 1993; Ahamefule, et al. 2006).

4.6.5. Potassium (K %)

Potassium content in the target species were (0.4±0.006- 0.9±0.04%), (0.5±0.04- 1.0±0.10%) and (0.2±0.05-1.1±0.1%) for grasses, forbs and shrubs, respectively (Table 4). These values is around the required levels of livestock (0.3- 0.8%) according to (NRC, 1984; Mayland and Shewmaker, 2001). Many species, during summer, showed a slight decline due to translocation and leaching of soluble K out of senescened parts, also live tissue have higher K% than dead tissues (Rumbaugh, et al. 1993; Grings, et al. 1996). During spring, species K% were higher at Sureif site than BaniNoem, this may due to increase of organic matter and minerals in soil that associated with high precipitation. During summer there's no difference between the two sites in species K content.

4.6.6. Nitrogen (N %)

Nitrogen content were generally around the normal range of species content found in other studies and exceed the levels of livestock requirements (1.0 – 1.5 %) (NRC, 1984; Mayland, and Shewmaker, 2001). N content of target species were decreased through dry period due to N loss through leaching and translocation from leaves and stems to crown and roots. Decomposition also contributed to the low levels of crude protein observed in abscised leaves. In addition, foliage nitrogen declines prior to leaf abscission when protein in older leaves is hydrolyzed and its breakdown products are translocated to the other plant parts (McDowell, et al. 1983; Msangi and Hardesty, 1993). *P. syriacum* N content was increased through summer this result probably due to the increased of pods and seed to leaf and stems ratios (Rumbaugh, et al. 1993; Garza, 1994). During spring, in most species N content at Sureif site were higher than BaniNoem due to higher of OM and soil fertility in Sureif site.

Conclusions

In conclusion, forbs and shrubs were higher in CP content than grasses during spring and summer and they were more than protein requirement of small ruminant. Grasses showed high content of fat and fibers. DM content of shrub species during summer was lower than grass and forbs content which recorded drastic increase during summer. Minerals content of species were around the normal levels except for P which recorded low contend during both seasons.

Recommendations

From the current study, under similar environmental conditions, we recommended the Following:

1. Phosphorus supplementation should be considered for range livestock in order to cover the needs of the grazing animals during the grazing period and to have a suitable Ca: P ratio.
2. In rehabilitation programs of rangelands, growing mixture of high nutritive species of shrub, forbs and grasses like (*P. syriacum*, *A. halimus*, *R. raetam*, and *A. cyanophylla* to provide livestock with highest level of forage quality and green forage during dry and long summer.
3. Further researches are needed to study the chemical composition, ecology and the physiology of palatable species, concentration of deterrent compounds, and phosphorous fertilization to range plants in West Bank.
4. *P. bulbusa*, *M. rotata*, *R. raetam*, *P. syriacum*, and *A. cyanophylla,* have low levels of Na % indicating the need for growing *Atriplex* spp as halophytic species between this vegetation groups.

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Abstract (Arabic)

الخلاصة

المركبات الكيميائية لنباتات المراعي السائدة جنوب الضفة الغربية

إن إعادة تأهيل المراعي في المناطق الجافة تتطلب مجموعة من الدراسات والبيانات والتي ترتكز عليها عملية التأهيل. إحدى أهم هذه المعلومات هي المكونات الكيميائية للنباتات الرعوية والتي عليها يبنى أساس الاختيار للأصناف والتركيبة النباتية للمراعي من حيث النجيليات والحشائش والشجيرات. تهدف هذه الدراسة إلى تحديد المكونات الكيميائية للنباتات الرعوية السائدة في المراعي الطبيعية والفرو قات بين المجموعات النباتية, والتغيرات بين الفصول والمناطق المختلفة. تم اخذ أصناف نباتية سائدة في المراعي بناءا على دراسات سابقة من منطقة بني نعيم كمناخ شبه جاف ومنطقة صور يف كمنطقة شبه رطبة من المجموعات النباتية الثلاثة وهي النجيليات (السبيلة (الخافور), النزعة,), الحشائش(العنجد, الدريدرة, البريد), الشجيرات (السنط الأزرق(أكاسيا), الشيح, القطف الملحي, الرتم), حيث أخذت العينات (أربع مكررات) من الأصناف المذكورة في فصلي الربيع والصيف وتم تجفيف وتحضير العينات للتحاليل المخبرية. وبعد إجراء التحاليل بينت النتائج أن المركبات الكيميائية للمجموعات النباتية ترتبط ارتباط وثيق بموسم اخذ العينات والمرحلة النضجية والشكلية للنبات.

أشارت النتائج إلى أن النجيليات بها أعلى نسبة من الألياف والألياف الذائبة بالمحلول ألحامضي والقاعدي واقل نسبة من البروتين مقارنة مع الحشائش والشجيرات, بينما (البريدة) من الحشائش التي تحتوي على نسبة عالية من البروتين في فصلي الربيع والصيف (20,5 – 19,5 %) , أما الخافور من النجيليات فسجل أعلى نسبة من الدهون والمادة الجافة والألياف الذائبة بالمحلول الحمضي فكانت على التوالي (5,9 و 99,3و 67,6 %) وكان به اقل نسبة من البروتين (5,5 %) صيفا . اقل نسبة للمادة الجافة كانت لـ (العنجد) خلال الربيع, و أعلى نسبة للألياف الذائبة في المحلول القاعدي كانت (81,1%) للنزعة واقل نسبة سجلت للاكاسيا فكانت (38,8%) , أما اقل نسبة للألياف الذائبة في المحلول الحمضي فكانت للقطف الملحي (21,5%). نسبة الرماد تراوحت بين (5,1 – 18,4 %) والصوديوم (0,01 – 1,04%), المغنيسيوم (0,1 – 0,6 %), الفسفور (0,01 – 0,02%), الكالسيوم (0,2 – 1,8%), والبوتاسيوم (0,2- 1,05%) . كان للاختلاف البيئي للموقعين اثر على المكونات الكيميائية للنباتات الرعوية, فأثرت المنطقة الشبه رطبة على الأصناف النباتية بسبب زيادة معدل الأمطار وبالتالي زيادة المادة العضوية وما له اثر

عل خصوبة التربة انعكس ذلك على زيادة البروتين وبعض العناصر في الأصناف النباتية مقارنة مع الموقع الآخر, أما المنطقة الشبه جافة ونتيجة لتدني المعدل المطري وزيادة درجة الحرارة وما له اثر على نقص المادة العضوية وفقر التربة انعكس ذلك على نقص بعض العناصر من الأصناف النباتية ونتيجة للنضج المبكر للأصناف زاد من نسبة الألياف وقلل من نسبة البروتين خلال موسم الربيع.

نستنتج من هذه الدراسة انه في مشاريع إعادة تأهيل المراعي يجب التركيز على النوعيات ذات القيمة الغذائية العالية وزيادة نسبة الشجيرات التي تزود الثروة الحيوانية بالأعلاف الخضراء في الصيف الطويل الجاف, زيادة نسبة التسميد الفسفوري للمراعي وزيادة الفسفور في الأعلاف التكميلية وذلك لتعويض النقص في نسبة الفسفور في النباتات عن الحد المطلوب للنباتات الرعوية, أما بخصوص القطف فيجب أن يكون جزء من العليقة النباتية وان لا يكون عليقة بمفرده وذلك لزيادة نسبة الصوديوم والعناصر (الأملاح) عن الحد المطلوب.