DEDICATION

To my Family

I dedicate this project

Soad A. Fadl

ACKNOWLEDGMENTS

I am grateful to God for supporting me in all my life.

I wish to express my gratitude to all whom, in some way or another contributed towards the completion of this work.

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List of Abbreviations

Dry matter intake	DMI
Water intake	WI
Nitrogen	N
Crude fibre	CF
Blood urea nitrogen	BUN
Rectal temperature	RT
Respiratory rate	RR
Ammonia	NH_3
Ammonia nitrogen	NH_3-N
Volatile fatty acids	VFA
Crude protein	CP
Plasma urea nitrogen	PUN
Organic matter	OM
Kilogram	Kg
Gram	G
Dry matter	DM
Total digestible nutrients	TDN
Nitrogen free extract	NFE
Ether extract	EE
Digestible crude protein	DCP
Metabolizeable Energy	ME

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Abstract

Four experiments were carried out with Nubian goats with the objectives of studying the effects of water restriction (experiment 1), feed and water restriction (experiment 2), type of feed (experiment 3) and water or feed restriction (experiment 4) on dry matter intake (DMI), water intake, digestibility of nutrients, ruminal components, blood urea-N (BUN) and some other physiological parameters related to animal performance. All the experiments were conducted at the experimental units of Animal Production Research Department, National Centre for Research located at Soba, Southeast Khartoum (from April 2005 to September 2006).

Experiment (1): Nine yearling uncastrated Nubian goats ranging in weights from 14 to 17 kg were used. They were randomly allocated to three treatments with 3 animals per treatment adlib water and feed (control) (T_1), water restricted to 50% (T_2) and water restricted to 100 % (T_3). During the experiment the animals were provided with alfalfa (*Medicago Sativa*) hay adlibitum.

Dry matter intake (DMI), WI, WI: DMI ratio, RT and RR are significantly (P<0.05) affected by water restriction whereas faecal DM output, urine volume are not affected by water restriction DMI decreased more by 100% water restriction than 50% and control.

Water restriction had no significant (P<0.05) effect on DMD; OMD and CPD but EED showed a significant (P<0.05) increase with 50% restriction and a significant (P<0.05) reduction in 100% restriction.

Water restriction had no significant affect (P>0.05) on ruminal pH, ruminal NH_3-N and blood urea nitrogen (BUN), pH and NH_3-N also were not significantly affected by sampling time.

N-balance and N-intake were affected highly significantly (P<0.01) by water restriction whereas faecal-N and urinary-N were not significantly affected by water restriction.

Experiment No. (2): Twelve yearling uncastrated males of Nubian goats ranging in weight from 11.5 to 17.5 kg were used in this experiment. They were allocated at randomly to each of the experimental treatments in 2x2 factorial arrangement of treatments which refered to adlibitum water and feed (control) (T_1) adlibitum water and feed restricted to 66.66% from adlibitum (T_2), water restricted to 33.3% and feed restricted to 66.66% from adlibitum (T_3), and water restricted to 33.3% from adlibitum and feed adlibitum (T_4) with three animals per each treatment DMI, WI, urine volume and faeces DM output are significantly (P<0.05) affected by treatments, whereby RT and RR were not, DMI decreased by all treatments compared to adlibitum water and feed (control) urine volume increased (p<0.05) significantly with treatment (T_1) (adlib water and feed restricted 66.66% from adlib.)

Digestibility of nutrients were not affected (p>0.05) by treatments except CPD which was decreased (p<0.05) significantly by feed restriction and feed and water restriction but not altered by water restriction.

Ruminal pH, ruminal NH_3.N and BUN were not affected by treatments (p>0.05) except BUN before feeding was significantly (p<0.05) decreased by treatments compared to control. Nitrogen intake was highly (p<0.01) significantly affected by treatments that it decreased by treatments. Also faecal N and N balance were significantly affected (p<0.05) by treatments, on the other hand urinary N, NB as % of N intake and NB as% of digested N were not affected (p>0.05) by treatments but they had a tendency to decrease compared to control.

Experiment No. (3): A comparison was made between two types of feed alfalfa hay and abu 70 hay in this experiment; twelve yearling uncastrated males of Nubian goats weighing 13-17 kg were used in this experiment. The animals were randomly allocated to one of the two types of feed (alfalfa hay or Abu70) to four treatments with two water regimes with three animals per treatment following the completely randomized design with a 2x2 factorial arrangement of treatments, adlibitum Abu70 water every 24 hrs(T_1), adlibitum alfalfa hay water every 24 hrs (T_2), adlibitum Abu70 hay water every 48 hrs(T_3), adlibitum alfalfa hay water every 48 hrs (T_4). DMI, WI, WI: DMI ratio, faecal DM output, RT and RR were not affected (P>0.05) by treatments and food types whereas urine volume was significantly (P<0.05) affected by treatment, there were insignificant (P>0.05) increase of DMI, WI, urine volume in alfalfa hay compared to Abu 70 hay.

Crude protein digestibility (CPD), EED, CFD, NFED and TDN are significantly (P<0.05) affected by both water restriction and feed type, whereas digestibility was improved with water restriction. Ruminal pH and ruminal NH_3-N was affected significantly (P<0.05) by feed type and treatments, whereas BUN was highly (P<0.01) significantly affected by feed type and treatments. N-intake and urinary N were affected significantly (P<0.05) by feed type they were increased with alfalfa hay more than Abu70 hay but not affected by treatments, faecal-N was not affected by feed type nor by treatments, N-balance was affected ($P<0.05$) by feed type that it was increased by alfalfa more than Abu 70 but was not affected ($P>0.05$) by treatments, NB as % of intake was significantly ($P<0.05$) affected by feed type that it was higher in Abu 70 more than alfalfa, but was not affected by treatments. NB as % of digested was highly ($P<0.01$) significantly affected by feed type and treatments.

Experiment No (4): A digestibility nitrogen balance experiment was conducted with six yearling uncastrated males of Nubian goats weighing 13 to 15 kg were used in this experiment, they were randomly allocated to one of the three nutritional treatments with two animals per treatment in a 3x3 Latin square design, the treatments were adlibitum water and feed (control) (T_1), water restricted to 33.3% from adlibitum and feed adlibitum(T_2), and water adlibitum and feed was restricted to 33.3% from adlibitum (T_3). The animals were interchanged between the treatments so that the six animals were employed in each treatment. The animals were provided with alfalfa hay all over the experiment DMI decreased ($P<0.05$) significantly with feed restriction compared to water restriction and control whereas water intake decreased ($P<0.05$) significantly with water restriction compare to feed restriction and control, faecal DM output and RT were not affected ($P>0.05$) by treatment. On the other hand urine volume was highly significantly ($P<0.01$) affected by treatments it was decreased by water restriction and increased by feed restriction, RR was significantly ($P<0.05$) decreased by both water and feed restriction. DMD, OMD, CPD, EED, CFD, NFED and TDN were affected significantly ($P<0.05$) by treatments whereas they were increased with water restriction and decreased with feed restriction. Ruminal NH_3-N was affected significantly ($P<0.05$) by treatments they increased with water restriction and showed tendency to increase with feed restriction compare to control. BUN was highly (P<0.01) significantly affected by treatments, it was increased with water restriction and decreased with feed restriction compare to control. N-intake was decreased (P<0.05) significantly with water restriction and feed restriction compared to control, faecal-N was not affected by treatments, N-balance was affected (P<0.05) by feed restriction that it was decreased with feed restriction but not affected by water restriction.

ملخص الاطروحة

أجريت أربعة تجارب على الماعز النوبى بهدف دراسة تأثيرات تقليل الماء التجربة رقم (1)، تقليل العلف والماء التجربة رقم (2)، نوع العلف تجربة رقم (3) تقليل العلف أو الماء التجربة رقم (4) وذلك على هضمية العلف، ميزان النتروجين، التخمر فى الكرش، يوريا الدم، درجة حرارة المستقيم ومعدل التنفس. أجريت جميع التجارب فى الوحدة التجريبية التابعة لقسم أبحاث الإنتاج الحيوانى، المركز القومى للبحوث بمنطقة سوبا جنوب شرق الخرطوم (من أبريل 2005 الى سبتمبر 2006).

التجربة (1): تم استخدام تسعة من ذكور الماعز النوبى الغير مخصية فى عمر سنة تتراوح اوزانهم من 14 إلي 17 كجم على ثلاث معاملات تم توزيعها عشوائياً فى تصميم قطاعى كامل العشوائية لتقدير تأثيرات تقليل الماء على المعايير المذكورة اعلاه. اعطيت المجموعة الأولى دريس البرسيم (علف) حتى الشبع مع ماء حتى الارتواء (المعاملة الأولى) وعلف حتى الشبع مع تقليل الماء الى 50% من مستوى الارتواء (المعاملة الثانية)، وعلف حتى الشبع و0% ماء المعاملة الثالثة .

كان هناك تأثير معنوي ($P<0.05$) على المادة الجافة المأكولة، ماء الشرب، نسبة ماء الشرب الى المادة الجافة المأكولة،درجة حرارة المستقيم ومعدل التنفس، من ناحية ثانية لم يكن هناك تأثير معنوى ($P>0.05$) بتقليل الماء 50% أو 100% على المادة الجافة للروث وحجم البول.

الملاحظ أن المادة الجافة المأكولة نقصت فى 100% تقليل الماء أكثر من 50% تقليل الماء.

لم يحدث تقليل الماء تأثيراً معنوياً ($P>0.05$)على معامل الهضم الظاهرى للمادة الجافة، والمادة العضوية، والبروتين الخام، لكن هضمية مستخلص الإيثر احدث زيادة معنوية ($P<0.05$) بتقليل الماء الى 50% من حد الارتواء ونقصاناً معنوياً ($P<0.05$) بتقليل الماء الى 100%، لم يكن هناك تأثيراً معنوياً ($P>0.05$) بتقليل الماء على الرقم الهيدروجينى (pH) نتروجين الامونيا ويوريا الدم. ايضاً لم يكن هناك تأثير معنوى ($P>0.05$) للأمونيا نتروجين والأس الهيدروجينى ويوريا الدم فى زمن أخذ العينة. أظهر ميزان النتروجين والنتروجين المأكول تأثيراً معنوياً ($P<0.05$) بتقليل الماء بينما لم يتأثر بتقليل الماء كلا من نتروجين الروث ونتروجين البول.

التجربة(2): استخدم 12 من ذكور الماعز النوبى الغير مخصى فى عمر سنة والتي تتراوح اوزانها مابين11.5 الى 17.5كجم وزعت عشوائياً على أربعة معاملات بمعدل ثلاث

حيوانات لكل معاملة فى تصميم قطاعى كامل العشوائية بتنظيم عامل 2X2. المعاملات كانت كالاتى:

1- علف حتى الشبع وماء حد الارتواء.

2- ماء حد الارتواء وعلف 66.66% من الشبع.

3- ماء 33.3% من حد الارتواء وعلف 66.66% من الشبع.

4- علف حتى الشبع وماء 33.3% من حدالارتواء.

احدثت المعاملات اثراً معنوياً (P<0.05) فى المادة الجافة المأكولة، ماء الشرب المستهلك، حجم البول و المادة الجافة للروث، بينما لم يحدث تاثيرا معنويا (P>0.05) فى درجة حرارة المستقيم ومعدل التنفس. لكن المادة الجافة المأكولة اظهرت نقصاناً معنوياً (P<0.05) فى كل المعاملات مقارنة بالمعاملة الضابطة. فى الجانب الاخر حجم البول اظهر ارتفاعا معنويا (P<0.05) مع تقليل العلف مقارنة مع كل المعاملات الاخرى . معامل الهضم الظاهرى للمواد الغذائية المختلفة لم تظهر تأثيراً معنويا (P>0.05) من تقليل العلف أو تقليل العلف والماء أو تقليل الماء ماعدا معامل الهضم الظاهرى للبروتين الخام حيث اظهر تأثيرا معنويا (P<0.05) من تقليل الماء وتقليل العلف والماء ولم يحدث تأثيرا معنويا من تقليل الماء فقط مقارنة بالمعاملة الضابطة.

لم يتأثر الرقم الهيدروجينى ونتروجين الأمونيا ويوريا الدم فيما عدا يوريا الدم قبل الاطعام حيث لوحظ انخفاضا معنويا (P<0.05) ليوريا الدم عند اخذ العينة قبل الاطعام . أظهر النتروجين المتناول تأثيرا معنوياً (P<0.01) مرتفعا من تقليل العلف وتقليل الماء مقارنة بالمعاملة الضابطة. فى الجانب الاخر اظهر نتروجين الروث وميزان النتروجين تأثيرا معنويا (P<0.05) من تقليل العلف و تقليل العلف والماء وتقليل الماء مقارنة بالمعاملة الضابطة. فى الجانب الاخر نتروجين البول وميزان النتروجين كنسبة من النتروجين المأكول و ميزان النتروجين كنسبة من النتروجين المهضوم لم يحدث فيها تأثيرا معنويا (P>0.05) ولكن لوحظ فيها انخفاضا قليلا مقارنة بالمعاملة الضابطة.

التجربة (3): تم عقد مقارنة بين نوعين من العلف دريس برسيم وتبن الذرة . تم استخدام 12 من ذكور الماعز النوبى الغير مخصيه فى عمر سنة تتراوح اوزانها مابين 13 إلي 17 كجم وزعت عشوائياً على نوعى العلف والمعاملات بمعدل ثلاثة حيوانات لكل معاملة فى تصميم قطاعى كامل العشوائية بتنظيم عاملى 2X2.

1- تبن ذرة حتى الشبع وماء كل 24 ساعة.

2- دريس البرسيم حتى الشبع وماء كل 24 ساعة.

3- تبن ذرة حتى الشبع وماء كل 48 ساعة.

4- دريس برسيم حتى الشبع وماء كل 48 ساعة.

لم تظهر المادة الجافة المأكولة، ماء الشرب المستهلك، نسبة ماء الشرب المستهلك للمادة الجافة المأكولة، المادة الجافة للروث، درجة حرارة المستقيم ومعدل التنفس تأثراً معنوياً ($P<0.05$) بالمعاملة ولا بنوع العلف بينما أظهر حجم البول تأثراً معنوياً ($P<0.05$) بالمعاملة. من جهة أخرى لوحظ ارتفاعاً غير معنوى للمادة الجافة المأكولة وماء الشرب المستهلك وحجم البول فى دريس البرسيم مقارنة بتبن الذرة. معامل هضم الذرة للمواد الغذائية أظهر تأثراً معنوياً ($P<0.05$) بتقليل الماء ونوع الغذاء. تاثر الرقم الهيدروجينى (pH) ونتروجين الأمونيا تأثيراً معنوياً ($P<0.05$) بنوع العلف والمعاملة ومن الناحية الاخرى لوحظ تاثراً معنوياً($P<0.01$)عالياً ليوريا الدم بنوع العلف والمعاملة. نتروجين الروث لم يتأثر بنوع العلف ولا بالمعاملة لكن ميزان النتروجدين تأثر تاثراً معنوياً ($P<0.05$) بنوع العلف وقد لوحظ ارتفاعاً معنوياً لميزان النتروجين مع دريس البرسيم أكثر من تبن الذرة لكن لم يتأثر بالمعاملة لوحظ تاثراً معنوياً ($P<0.05$) لميزان النتروجين كنسبة مئوية من النتروجين المتناول بنوع العلف حيث انه سجل ارتفاعاً معنوياً ($P<0.05$) مع تبن الذرة مقارنةً بدريس البرسيم لكنه لم يتأثر بالمعاملة، من الجهة الاخرى سجل ميزان النتروجين كنسبة مئوية من النتروجين المهضوم تأثراً معنوياً مرتفعاً بنوع العلف والمعاملة.

التجربة (4): أجريت تجربة هضم ميزان نتروجين على ستة حيوانات من الماعز النوبى الغير مخصى فى عمر سنة تتراوح اوزانهم بين 13-15 كجم باستخدام تصميم 3X3 مربع لاتينى بهدف دراسة تأثير تقليل الماء أو تقليل العلف على المادة الجافة المأكولة، ماء الشرب المستهلك، هضمية المواد الغذائية، محتويات الكرش، يوريا الدم وبعض المعايير الفسيولوجية الاخرى المرتبطة باداء الحيوان. تتكون التجربة من ثلاث معاملات:

(T_1) علف حتى الشبع وماء حد الارتواء.

(T_2) ماء 33.3% من حد الارتواء وعلف حتى الشبع.

(T_3) ماء حد الارتواء وعلف 33.3% من حد الشبع.

فى هذا النظام تتبادل الحيوانات كل المعاملات مما يعنى أن الستة حيوانات قد اُستُخدموا فى الثلاث معاملات فى ثلاثة فترات (فترة أولى وثانية وثالثة) العلف المستخدم هو دريس البرسيم فى كل تجربة. لوحظ نقصاناً معنوياً ($P<0.05$) للمادة الجافة المأكولة مع تقليل العلف مقارنة مع تقليل الماء والمعاملة الضابطة ، من ناحية أخرى لوحظ انخفاضاً معنوياً

(P<0.05) لماء الشرب المستهلك مع تقليل الماء مقارنة بتقليل العلف والمعاملة الضابطة ، كمية المادة الجافة للروث ودرجة حرارة المستقيم لم يتأثرا معنوياً (P>0.05) بالمعاملة بينما تأثر حجم البول تأثراً معنوياً مرتفعاً (P<0.01) مع المعاملات حيث انخفض مع تقليل الماء وزاد مع تقليل العلف. معدل التنفس انخفض معنوياً مع تقليل الماء وتقليل العلف، اظهرت المعاملة تأثراً معنوياً على معامل الهضم الظاهرى للمواد الغذائية (P<0.05) حيث شكل ارتفاعاً معنوياً مع تقليل الماء ونقصاناً معنوياً مع تقليل الغذاء.

لم يتأثر الرقم الهيدروجينى pH بالمعاملة ولا بزمن اخذ العينة. تأثر نيتروجين الامونيا تاثراً معنوياً (P<0.05) بالمعاملة ولوحظ تأثراً معنوياً مرتفعاً (P<0.01) ليوريا الدم حيث انه زاد مع تقليل الماء ونقص مع تقليل العلف ولكنه لم يتأثر بزمن أخذ العينة. أظهر النايتروجين المتناول نقصاناً معنوياً (P<0.05) مع تقليل الماء والغذاء بينما لم يتأثر (P>0.05) نتروجين الروث بالمعاملات، ميزان النيتروجين أظهر تأثراً معنوياً (P<0.05) مع تقليل الغذاء حيث سجل قيمة سالبة مع تقليل الغذاء بينما لم يتأثر (P>0.05) مع تقليل الماء.

Chapter One

Introduction

Under tropical environmental conditions, the most abundant sources of ruminant feeds are natural pasture, crop residues and agro-industrial by products. The availability of these feed resources to livestock was limited by a variety of environmental factors such as fluctuation of rainfall. In the semi-arid tropics, the low rainfall is erratic and is virtually confirmed to the months of July and August in the northern hemisphere.

A dynamic balance between water gain and water loss usually maintains, within narrow limits, the amount of total body fluid in ruminants (Andersson, 1978), ingestion of water and urinary water excretion are controlled by the animal in the process of regulating body water volume (Houpt, 1977).

During the prolonged dry season that prevails in semi-arid regions, livestock graze far from their widely spaced watering sites and usually subsist on low quality pasture. However infrequent drinking may significantly improve feed digestibility in desert ruminants maintained on low quality pasture (Brosh *et al*., 1987). Low quality feeds are high in plant cell wall constituents and low in protein.

Most breeds of tropical goats owe their existence to their ability to survive period of drought and under nutrition. During periods of surplus feed, energy can be stored whereas during time of scarcity, energy may be used sparingly and efficiently (Robert-shaw, 1986). The goat's population in the Sudan is distributed throughout the country. They were estimated as 32 million heads (MARIC, 2013).

Their importance is associated with their contribution to supplies of meat, milk and skin as well as manure. In many parts of the world goats usually move with nomads throughout the year in search of quality pasture and water. However concentration of livestock around water resources creates situations where there is some water but no more forage, and where there is forage but no water (Qureshi, 1986). However desert sheep and goats are well adapted to water shortage and can easily stand watering intervals of 3-6 days (Wilson *et al.*, 1962). Animals would also respond to water shortage by producing concentrated urine and faeces (English, 1966 little *et al.*, 1976, More and Sahni, 1978).

In Sudan, natural rangeland is of great importance across all ecological zones of the country. Several factors have contributed to range degradation; among the most important of these are overgrazing and expansion of traditional rain fed farming in marginal rangelands. Also seasonal uncontrolled fire was estimated to remove annually 35% of the total forage production. Most of the perennial herbaceous vegetation was replaced by short-lived annual of low nutritional value. Deterioration of range lands is mainly attributed to intensive grazing of both nomadic and sedentary livestock due to availability of drinking water. Furthermore, in the grazing open system, nomadic tribes graze range resource without contribution to the conservation and rehabilitation, hence stoking rate is not in balance with actual carrying capacity of the grazing resource consequently, shortage of forage resulted in rapid increase in live stock malnutrition, health complication and mortality (Wilson *et al.*, 1962).

Nubian goats which were used in these experiments are among the best known dairy breeds in Africa especially in Sudan. This breed plays an important role in the life of many Sudanese families and a household animal kept for milk, it's raised under traditional system, usually roaming freely during the day, screening in towns then confined and fed household wastes and concentrates at night. Kidding interval is 228±17 days with multiple births being fairly prolific. High proportion of singles (60%) occurs, while twin and triplet percentages are 30 and 3, respectively (El Naim, 1979).

Little was done to raise the awareness for the potential of small ruminants, especially goats, to stimulate their introduction into animal research and economic development programs.

The purpose of the present studies is to investigate the effects of the following on the performance of Nubian goats:

1. Restriction of the water intake to 50% and 100% restriction.
2. Restriction of water and feed intake.
3. Increasing the watering interval to 24hrs and 48hrs using two types of feed Alfalfa hay and Abu 70 hay.
4. Water or feed restriction.

Chapter two

2. Literature Review

2-1 Rumen microenvironment

The rumen environment is controlled by many factors such as type and quantity of feed eaten, periodic mixing through rumen contraction, salivation and rumination, diffusion or secretion into the rumen, absorption of the nutrients from the rumen and passage of material down the digestive tract (Preston and Leng, 1987).

The rumen contains a large and variable microbial population which on a particular dietary regime is broadly stable although it may show considerable diurnal fluctuation depending upon the pattern of feeding (Bryant, 1972).

The rumen microbial output environment is complex consisting of aerobic protozoa, bacteria and fungi Smith and Oldham (1983). The major output of fermentative product is dominated by rumen bacteria of which are polysaccharide, fermenting species, sugar fermenting species, lactate fermenting species and methanogenic species.

Symbiotic relationship exists between this microbial population and the host animal. Within the rumen, the host provides an environment that favours anaerobic microbial growth in which temperature, pH and redox potential are controlled and both exogenous and endogenous nutrients are provided and the end products of fermentation removed (Smith and Aldham, 1983). The microbial ecosystem in the rumen vary within an animal, with time after feeding between days in the same animal and apparently in animal in different countries on similar feeds (Hungate, 1975) microbial growth rates and yields are important for both energy utilization and protein production in ruminant animal, it is influenced by the efficiency of adenosine triphosphate (ATP) production, and by the efficiency with which the ATP is used for synthesis (Smith and Oldham, 1983) production of ATP may vary theoretically according to what is fermented and what end product are formed Johnson (1976) proposed that microbial growth efficiency and hence animal performance may be improved by manipulating the rate and synchronization of energy and nitrogen supply to the rumen, availability of nitrogen containing substrates ammonia and amino acids, peptides must be synchronized with providing energy yielding nutrients in order to optimize microbial growth and efficiency of nitrogen utilization (Oldham *et al*., 1977).

The ruminant can also make much more effective use of simple nitrogenous compounds or unbalanced amino acids than simple-stomach animals, microbial degradation and synthesis in the rumen entails that amino acids composition of digesta entering the duodenum approaches that of microbial protein which of high biological value, however, dietary protein may be downgraded in value because bacterial nitrogen (N) contains about 15% nucleic acid, which is of limited value to the host (Smith, 1975).

The normal pH ranges from 5.5 to 6.5 for maximum NH_3 absorption (McDonald, *et al*., 1988). As the pH of the rumen is raised, more of the ammonium ions (NH_4^+) are converted to NH_3. The rumen epithelium is more permeable to NH_3 but not to NH_4^+ (Bloomfiled *et al*., 1963) variation in pH between 7 and 6.2 exert minor effect on microbial activity. (Shiver *et al*., 1986), however, as pH falls below 6.2, a marked decrease in microbial activity occurs (Mould and Orskov, 1983). Substantial fall in pH accompanies feeding of diets with high content of easily degradable carbohydrate such as starch (Kellway *et al.*, 1978). Ruminal pH is affected by time after feeding and by type of diet (Church, 1979) (Mudgal *et al*., 1982).

2-2 Feeding habits and behavior

Goats are very inquisitive animals much more than other ruminants and they can walk long distances in search of food. This feeding behavior assists them in meeting their nutrient requirement, the wide distribution of goats, from the temperate zone to the semi-arid and super humid tropical environment, is possibly to their ability to feed on a wide variety of food stuffs mainly tree, shrub leaves and grasses. They are able to utilize feeds normally not be eaten by cattle and sheep. While goats will accept a wide variety of feeds, they are, contrary to popular opinion, fastidious in their feeding habits, feed that is acceptable to one goat is sometimes not acceptable to another, and goats usually refuse anything that had been spoiled by other animals. Goats can distinguish between bitter, sweet, salty and sour tastes, and show a higher tolerance for bitter taste than cattle. They refer to select from many varieties of feeds, such as a combination of grasses and shrub plants or tree leaves (Devendra and Mcleroy, 1982).

Goats tend to nibble at the shoot and leave of growing plants and reject the stems. Even the same plant many be consumed at one time and rejected at other times. Palatability appears not to be an overriding consideration. The most important factor affecting choice of feed is the availability of a variety of feeds (Qureshi, 1986).

2-3 Water intake

Goats are efficient animals in the use of water. They have a low rate of water turnover per unit of body weight. Amble quantities of clean water are essential for high milk production by lactating goats and for maximum growth and mohair production. The water requirement of meat animals are relatively less (ElNaim, 1979).

In the tropics goats are adapted to water shortages; they often have low water turnover rates. The demand for water increases in the dry season, which is often the season at which ambient temperatures are highest. In hot environments (about 38˚C), goats pant at half the rate of sheep, do not sweat, and lose less water in their faeces and urine. When water intake is low and animals go for days without drinking water, the excretion of urine is reduced. In East Africa, the tolerance to heat stress by goats considered to be due to resistance to the absorption of radiant heat by the shiny coat, reduced water loss in urine and faeces and increased ventilation rate (Devendra and Mcleroy, 1982).

Goats raised for meat production in Malaysia consumed 680 ml water per animal per day. The goats consumed approximately 4 times the amount of water during the day (554 ml) than at night (136 ml), dry matter intake and water intake are strongly correlated, and inadequate water supply can, therefore restrict food intake. This restriction is more severe at higher ambient temperatures it is essential that a dry matter intake to total water intake ratio of 1 to 4 or 5 be maintained (Devendra and Mcleroy, 1982).

2-4 Dry matter intake

The dry matter intake of goats indicates their capacity to utilize feed voluntarily. Intake depends on the breed of goat (meat or milk type) and on environment.

Dairy goats in tropics usually consume dry matter at the rate of 4 to 5 percent of live weight. Meat goats in the tropics seldom exceed an intake of 3 percent of live weight (English, 1966).

Goats are classified into a flexible system of three morphophysiological types concentrate selector, grass and roughage eaters and intermediate opportunistic, mixed feeders (Hofmann, 1989).

In general, some of the physiological features of ruminants defined as intermediate feeders are large salivary glands, large absorptive area of the rumen epithelium, and capacity to rapidly change the volume of the foregut in response to environmental changes (Silanikove, 2000). The dry matter intake of goats indicates their capacity to utilize feed.

Voluntarily Intake depends on the breed of goat and on the environment, (Devendra and Mcleroy, 1982).The minimum protein requirement for maintenance in the tropics range from 0.590 g digestible crude protein (DCP) per wkg 0.75 to 2.57 DCP per wkg 0.75. The variability arises from the experimental technique, particularly if a variety of nitrogen free low-nitrogen or nitrogen rich diets, are given whatever diet is used, it is important to ensure that adequate energy is provided. Fibrous diets, for example may require supplementation with nitrogenous material and the protein requirement determined are relatively higher (Devendra and Mcleroy, 1982).

Goats appear to be more efficient in digesting coarse feeds than sheep and cows. In the tropics where roughage feeds are often particularly course this may be significant.

Greater efficiency of digestion of fibrous feeds means that the ME intake is higher, and goats may well be deriving more energy from available feeds in the tropics, than either sheep or cattle (Devendra and Mcleroy, 1982).

There is a complex interaction between the diet and microbial ecosystems in the rumen (Leng *et al*., 1983). Efficient microbial growth in the rumen depends on maintaining an adequate rumen outflow rate, which may be achieved by providing, the appropriate type and amount of roughage in a high energy diet (Preston and Leng, 1980). The primary factor affecting the intake of low quality roughage is the rate of physical breakdown of digesta particles that will leave the rumen (Leng *et al*., 1983) low quality roughages may be deficient in nitrogen or some other nutrients.

This may limit food intake either through retarded rumen function (where bacterial growth and requirements are not met) or through direct effect of -nutritional deficiency on metabolism (McDonald *et al*., 1972). A reduced protein content of the ration will depress food intake (Elliot, 1966).

The critical level of protein inclusion depends on the forms in which N is supplied. Provided a readily fermentable source of N is available together with an adequate supply of amino acids in the correct proportions, it is possible that protein levels up to 13% will be adequate for animal requirements (Roffler and Satter, 1975). Capacity of adaptation leads to lower body weight losses when animals are subjected to feed restriction. Kouakou *et al*. (2008) fed goats at 25% level of maintenance they found a significant decrease in DMI and faecal output and the animals lost 10% of their weight Teixira *et al*. (2006) also found that when goats were fed 30% level of intake, live weight, DMI and WI decreased significantly compared with ad libitum intake of food.

Similar results were obtained by Ahmed and ElShafei (2001) and Ahmed and Elkheir (2004) in Sudanese goats subjected to food restriction. A decrease in DMI was also observed with low level of restriction (Tovar-luna *et al*., 2007). Ruminal digestion of a diet depends both on microbial activity and on the time of contact between microbes and particles. Microbial activity is the result of both intrinsic activity of bacteria and protozoa and size of feed particles that determine the surface area available for microbial attachment and enzymatic attack, and contributes to microbe-particle interaction (Doreau *et al*., 2003). Moreover, salivation during mastication allows wetting of the ingested feed, a process that required for the association of micro-organisms and feed particles and the initiation of the attachment process (McAllister *et al*., 2001). A decrease in feed intake results in more mastication, by longer time spent eating and ruminating per kilogram (kg) ingested feed (Ulyatt *et al*., 1984). As a consequence ruminal particles size decrease (Mudgal *et al*., 1982) the surface of attack by microbes increases and the structures more disrupted by chewing. Doreau *et al*. (2003) demonstrated that the more intake decrease the more ruminal particles retention time increases.

2-5 Importance of water for the animal

Water constitutes about 70% of the body weight of adult tropical ruminants (Macfarlane and Howard, 1972). Under semi-arid conditions and daily watering regime, indigenous livestock turnover 5-30% of their body water pool depending on animal species and season (King, 1979).

There are three sources of water for the animal; drinking water, water contained in feeds and metabolic water. Most of water that is utilized by the animal's body is ingested either as drinking water or as a component of feed (Woodford *et al*., 1984). However water is used by the herbivore as a medium for physical and chemical energy transfer for evaporative cooling and intermediary metabolism.

The total amount of water in the body remains relatively constant from day to day this depends upon balance between gain and loss of water by the body. Water loss occurs in urine, from the skin, with expired gases and in the faeces. Lactating animals also lose large amounts of water in milk (Houpt, 1970). Ruminants in arid lands are known for their capacity to withstand prolonged periods of water deprivation and graze far away from watering sites (Silanikove, 1994), moreover, breeds of sheep and goats are known for their adaptability to little water consumption whereas their domestic counterparts depend on an adequate and regular water supply for their metabolic activities (Ajibola, 2006). Restriction in water availability may result in poor animal nutrition, though a small degree of restriction does not appear to be harmful in practice (Hadjieorgiou *et al*., 2000). Limitation of water was found to decrease N losses in urine, increase urea recycle to the gut and improve N balance of desert goats, sheep and camels (Mousa *et al*., 1983). Goats appear to be more efficient users of water than sheep (Benlamlih and Pomeyrs, 1987).

Ferreira *et al*. (2002) measured that water intake of castrated Boer goat kids and Merino lambs indoors they found that goats had a lower water intake per kg of feed intake (1.8 vs 2.61) and per kg of live weight gain (16.4 vs. 24.41) for goats and sheep respectively. Alamer (2009) demonstrated that DMI was reduced in goats subjected to 25% and 50% water restriction compared with goats on free access of water consumption. Animals also reduce the amount of water lost in faeces and urine during the period of scarcity (Ahmed and Abdelatif, 1994).

Limitation of water intake depresses animal performance quicker and more drastically than any other nutrients efficiency. Water deprivation affects feed intake, metabolism and productivity (Steiger *et al*., 2001) it also results in an increase in RT and RR and arises in urea in blood and milk in sheep (Sevi *et al*., 2009).

Restriction of water resulted in a decrease in DMI in desert sheep and goats when water was reduced to 50% of adlibitum intake (Ali *et al*., 1984) Ahmed and Elshafei (2001) found that DMI was not affected by water restriction in desert goats fed high and low quality roughages, generally desert sheep and goats are well adapted to water shortage and can easily withstand watering interval of 3-6 days (Wilson *et al*., 1962).

2.6 Digestibility

The digestibility of a food is most accurately defined as the proportion that is not excreted in the faeces and that is, therefore, assumed to be absorbed by the animal. It is commonly expressed in terms of dry matter and as a coefficient or a percentage (McDonald *et al*., 2010).

2-6-1 Factors Affecting Digestibility

2-6-1-1 Food composition

The digestibility of a food is closely related to its chemical composition, and a food such as barley, which varies little in composition from one sample to another, will show little variation in digestibility. The digestibility of foods may be reduced by nutrient deficiencies or excesses, particularly in ruminants. For example, a deficiency of rumen-degradable nitrogen or sulphur may restrict microbial protein synthesis and thus reduce fibre digestibility. An excess of dietary lipid will also inhibit the activity of rumen microorganisms (McDonald *et al*., 2010).

2-6-1-2 Ration composition

The digestibility of a food is influenced not only by its own composition but also by the composition of other foods consumed with it. These associative effects may be positive or negative, although negative associative effects are perhaps the most common. A positive associative effect occurs when the digestibility of one ration component is enhanced by feeding it in combination with another. For example, the digestibility of poor-quality forage such as straw may be enhanced by feeding it in combination with a protein supplement (McDonald *et al*., 2010).

2-6-1-3 Food processing

Foods are often processed before feeding in order to increase and optimize their digestibility. The commonest treatments applied are normally chopping, chaffing, crushing and grinding (McDonald *et al*., 2010).

2-6-1-4 Animal factors

Digestibility is more a property of the food rather than of the animal consuming it. However, this is not to say that a food given to different animals will be digested to the same extent. The most important animal factor affecting digestibility is animal species. Foods that are low in fibre are equally well digested by both ruminants and non-ruminants, but foods high in fibre are better digested by ruminants (McDonald *et al*., 2010).

2-6-1-5 Level of feeding

An increase in the quantity of food consumed by an animal generally causes an increase in the rate of passage of digesta. The food is then exposed to the action of digestive enzymes for a shorter period of time and digestibility is reduced (McDonald *et al*., 2010).

2-7 Digestive efficiency

The digestion of roughage in ruminants is a function of the microorganisms in the rumen, then the primary limitation to digestion is the growth of the microbes in the rumen, the level of rumen ammonia and energy limits the growth of the rumen microbes. Ammonia provides the rumen bacteria, protozoa and fungi with the needed (N) for their growth. The level of ammonia that supports optimum digestibility of fibrous diets is sustained throughout the day to affect maximum fibre digestion (Alvarez *et al*., 1983). Ruminants differ from monogastric animals because much more saliva is secreated during eating (Bailey, 1961) and because they have a large fluid reserve in the rumen, which can buffer osmotic changes in the rumen derived from digesta, pygmy goats (Langhans and Meyer, 1991) reduced food intake during water deprivation and did not compensate for dehydration, induced weight loss by increasing food during the subsequent rehydration period. These results contrast findings in rats which are known to compensate for dehydration-induced body weight loss by markedly increasing food intake during the subsequent rehydration (Adolph, 1947). This different response suggests that ruminants are better able to cope with dehydration than rats, i.e. a similar degree of dehydration presumably provokes a smaller energy deficit in ruminants than in rats. Two mechanisms may contribute to the limitation of the dehydration induced energy deficit in ruminants:

1-The digestibility of forage-based diet may be higher during dehydration (Brosh et *al*., 1987).

2-Resting metabolic rate may be decrease with dehydration (Brosh *et al*., 1986). Water restriction caused an increase in the apparent digestibility of organic matter and energy, which helped to maintain energy balance.

It is unlikely that the better digestibility during water restriction was an artifact of that short collection period of only 5 days because others reported similar results with longer adaptation and collecting periods (Silanikove, 1985).

One reason for the better digestibility is probably a longer mean retention time of the digesta in the gastrointestinal tract, in addition to a decrease in the size of particulate matter in the rumen (Choshiak, *et al*., 1988), so the marked osmotic changes that presumably occurred every morning when the cows quickly consumed the allotted amount of water did not seem to inhibit the fermentation capacity of the rumen microorganisms (Brosh, A. *et al*., 1983).

The apparent digestibility of nitrogen was not improved and, in fact, the nitrogen balance became negative when water was restricted (Brosh *et al*., 1987) found the dehydration induced increase in nitrogen digestibility to be inversely related to the quality of the diet. The negative nitrogen balance was due to the relative increase in nitrogen excretion (in % of intake) in form of urinary urea and partly, milk urea as the result of the elevated plasma concentration of urea. Tissue protein breaks down and the subsequent increase in amino acid catabolism was the most likely source of the increase in plasma urea concentration.

Recycling urea in the kidneys helps to reduce urinary volume and, hence, to conserve water (Maltz, *et al*., 1981). The increased plasma urea content was unlikely to be a consequence of the reduced nitrogen needs for milk production because water restriction increases plasma urea also in non lactating animals (Qinisa, *et al.,* 1998), energy was used for maintenance and milk production, when water is limited, milk production declines according to the water and nutrients shortage (Dahlborn, 1987). Although water restriction reduces the food intake of an animal, it was found that it improved efficiency and digestion of DM by desert animal (Brosh *et al*., 1983).

The digestibility of CP was found to be improved by water stress in sheep (Osman and Fadlalah, 1974). Mousa et al., (1983) found that camels, desert sheep and goats of Sudan increased their protein digestibility coefficient by 5.2%, 7.6% and 5.7% respectively when they were given only 50% of their daily requirements for 8 days. Furthermore in desert sheep, the digestibility coefficient of NFE was found to increase when water was restricted to 50% of their daily requirement for 8 days, while that of others decreased (Osman and Fadlalah, 1974).

Maloiy and Taylor (1971) reported that although the reduction in water intake resulted in a fall in the feed intake of ruminants, it improved their nitrogen balance, and nitrogen retention tended to increase when water was restricted and was negatively correlated to total N excreted in the urine. Bergner *et al*., (1989) observed a negative N balance when water was restricted to 33.3% of free intake and feed Lucerne was given at maintenance.

Burgos *et al*., (2001) reported a negative N-balance in Lactating cows when their water intake was restricted to 50%, Atti *et al*., (2002) observed that when animals are fed very low level of intake, digestibility remain constant or sometimes decreases, and longer retention time cannot improve the digestibility of the diet because of the limitation of microbial activities. Doreau *et al*., (2003) observed a decrease in OM digestibility at intake lower than maintenance level in sheep. Teixeira *et al*., (2006) found that the digestibility coefficients for nutrients (except for CP) did not differ between ad libitum and 30% restriction of feed in goats.

Clark *et al*. (2007) reported that digestion of dry matter (DM) by cattle was greater when feed was restricted to 80% of the ad libitum level.
Teixeira *et al*. (2006) observed higher CP digestibility when feed was restricted to 60% of the ad libitum level. On the contrary, Ahmed (1989) and Bhatti *et al*. (2008) did not observe any variations in digestibility coefficients of nutrients as a result of feed restriction.

2-8 Protein and carbohydrate metabolism

The utilization of dietary nitrogen of protein and non- protein origin is closely related to the energy intake (Klopfenstein, 1991). Proteins are fermented in the rumen to peptides, amino acids and ammonia by bacterial proteases and peptidases. The ruminants derive their protein from microbes grown in the rumen and digested in the small intestines as well as from dietary protein not ruminally degraded (Klopfenstein, 1991). Carbohydrates are fermented in the rumen to volatile fatty acids, the rumen microorganisms must be supplied with adequate ammonia and sulphur (Chalupa *et al*., 1968).

2-9 Relationship between feed intake and water intake

Restriction of water intake has often been shown to reduce food intake in humans (Engell, 1988) and various animal species including ruminants (Little *et al*., 1976).

Most animals reduce their feed intake during water restriction and may not eat at all during severe dehydration a marked reduction in the ratio of water intake to dry matter intake during water restriction was shown to reduce water losses in urine and feaces associated with a slight increase in the efficiency of digestion Ikthaua *et al*. (1985), water intake related to food intake through its functions in the processes of digestion, elimination of undigested residues and the excretion of waste products of metabolism (Philips, 1960). Silanikove (1985) reported that restriction of water did not have any significant effect on DMI. As feed intake decrease or increase, there is a concomitant changes in faecal urinary and evaporative water losses and accordingly in water requirement (Abdelatif and Ahmed, 1992; Sirohi *et al*., 1997).

Ruminants drink mostly in connection with feeding. Because of the close, direct relationship between DMI and WI, it has been customary to express water requirements as a ratio of dry matter intake.

Given the strong relationship between feed and WI, any feed improvement supplementation strategy should also consider the availability of water Abdelhamid, (2000) reported that in Friesian heifers highest feed consumption was obtained when water was available for 24 hour/day in both concentrate or roughage ration, when water availability period was decreased from 24 to 18 hours/day animals significantly decreased their hay intake, while concentrate intake was not affected.

A further decrease in water availability period to 15 and 12 hours/day respectively, resulted in a significant decrease in feed intake both roughage and concentrate ration, these decreases were most pronounced with roughage intake. More *et al*. (1983) reported that restriction of water to 50% from ad libitum reduce WI: DMI ratio in goats. Ahmed and El Shafei (2001) found that the WI; DMI ratio was higher with Lucerne than sorghum hay in desert goats.

2-10 Relationship between types of feed on water and feed intake

In the tropical pastoral systems of Africa and Australia, the feed for ruminants is confined for most parts of the year to highly fibrous mature natural pasture or crop residue. The nutritive value of such feed is low because of its low digestibility and reduced feed consumption. The major factor those constraints the sustainability of livestock production under tropical grazing systems is the inadequate nutritional value of the range biomass. Water requirement in animals is affected mainly by ambient temperature, dry matter intake, the nature of the food, individual variation, and physiological condition of the animal and frequency of drinking (Devendra and Bums, 1970).

A significant correlation between water consumption and dry matter concentration in the diet (Castle and Thomas, 1975). Clark and Quin (1949) studied the effects of intermittent watering on the food intake of marine sheep, they found that when sheep were fed on poor quality grass hay feed intake was not affected by restricting water drinking, but when they were fed on Lucerne water requirements were higher and feed intake was reduced.

The type of the diet especially its organic composition affects water metabolism in ruminants. Warren *et al*. (1974) who observed that Steers drank more water with alfalfa (19% crude protein) than with grass hay (2.6% crude protein). Water requirements varied with types of feed, this means an amount of water that was adequate at one time for a particular diet could be insufficient for another (Aganga *et al*., 1989), sheep require more water on high than on low protein diet, since the nitrogenous end products require large urine volume for excretion (Abdelatif and Ahmed, 1992; Sirohi *et al*., 1997). Similarly, higher proportions of salt or other minerals in the diet can result in more urine excretion and accordingly more water requirement Van Soest (1994) reported depressions in DMI when CP content of the forage was less than 7%, Animals prefers forages that have greater total nonstructural carbohydrate contents (Fisher *et al*., 2002; Foster *et al*., 2009) which contribute to the faster degradation and passage rate (Dewhurst *et al*., 2003). Foster *et al*., (2009) reported an increase in DMI when sheep were fed on legumes hay compared to grass hay Denek *et al*. (2006) found no difference in DMI when ram lambs were fed on wheat straw and alfalfa hay. Similar result was obtained by Ahmed and Elshafei (2001), when desert goats were fed two types of feeds (Lucerne hay versus sorghum hay).

Chapter three

3. Materials and Methods

3-1 Experimental animals

The animals used in these experiments were Nubian goats. About 6 months of age, weighing 12-17 kg, were bought from a market in western Omdurman (Elsheikh Abuzeid). The animals were then transported to the pens in Soba (from April 2005 to September 2006).

They have a typical characteristic of the Nubian breed. On their arrival the animals were rested, ear tagged and treated with levafas against endo parasites and sprayed with gamatox for control of ectoparasites and given a prophylactic dose of Almycine and maintained on dry bereseem (*Medicago Sativa*), or (Abu 70) which was fed during the experimental period. The animals were weighed and then divided according to their live weight into groups. The distribution of animals was based on similar groups of really equal weights. For all the studies the animals were housed in digestibility crates especially designed for urine collection. They were harnessed with canvas bags for faecal collection under shade with four open sides and having natural lighting and ventilation. Maximum and minimum temperature prevailing in the vicinity of the animals is shown in table (1).

3-2 Experimental Feeds

Two types of feed were used throughout these studies:

Lucerne hay (*Medicago Sativa*).

Abu 70 hay (*Sorghum vulgare*).

The fresh materials were dried under the sun, chopped and thoroughly mixed before feed each alone.

Table (1): Average minimum and maximum temperature during the experiments

No of experiment	Date of experiment	Average maximum temperature	Average minimum temperature
1	20 April to 12 May (2005)	46°C	37°C
2	16 December (2005) to 7 January (2006)	28°C	21°C
3	15 March to 22 April (2006)	46°C	35°C
4	7 July to 7 September (2006)	44°C	34°C

Source: Sudan Meteorology Authority.

Samples of feeds were analyzed at regular intervals according to the methods of Association of Official Analytical Chemists AOAC(1980).

3-3 Experimental Methods

Each period of study lasted for 22 days. 15 days adaptation period followed by a 7 days experimental period. Rectal temperature (RT) and respiratory rate (RR) were measured once daily at (9:00PM) before water and feed were offered. RT was measured to the nearest 0.1˚C using clinical thermometer inserted into the rectum for 1 min, while RR was measured by counting the flank movements for 1 min.

Food and water were offered approximately at the same time in the morning (9:00 PM)the feed was offered once per day and was weighed in a single balance (Mettle P6) to the nearest 2.0g, water was measured using graduated cylinder to the nearest 0.1 CC.

Food and water from the previous were measured in order to determine actual consumption. Samples of feed offered were taken daily, bulked at the end of collection period; the collected composites were divided into two portions, one dried at 60˚C and the other at 105˚C for chemical analysis and dry matter determination respectively. Digestion coefficients were calculated according to standard procedures (Schneider and Flatt, 1975).

Fecal bags were emptied daily before feed and water were offered the total daily amounts of fresh faeces excreted were weighed to the nearest 2.0g from which10% of each, was dried daily at 105˚C for 24 hours for DM determination and the remaining quantity was bulked and refrigerated at the end of the collection period, the composites were mixed well, subsampled, and dried at 60˚C for 24 hrs ground and used for chemical analysis (AOAC, 1980).

A few drops of concentrated sulphuric acid were used as a preservative in urine collection bottles. The volume of urine voided was measured daily and a 10% was stored at 4 ˚C for determination of total nitrogen content by the micro kjeldahl (El-shazly, 1958).

On the last day of each experimental period, the animals were fasted over night. Rumen liquor samples were collected before feeding, 3hrs and 6hrs post feeding. The samples were strained by a mesh-cloth and were immediately used for the measurements of pH. The rumen pH measured using pH meter (Electronic instrument. L.T.D, model 41600) rumen – $NH_{3-}N$ was determined as described by Conway (1957) using Conway units. Blood samples were withdrawn from Jugular Vein puncture into heparinized vacutainers immediately before, 3hrs and 6hrs post feeding the blood samples were allowed to clot and the serum was separated by centrifugation and stored at -20˚C assayed for blood urea nitrogen (BUN) (Conway, 1957).

All the observations were recorded when the animals were in resting state under shade at 9.00 o'clock. The parameters investigated were: DMI, WI, Faecal DM output, urine volume, RT, RR, digestibility coefficient of the various nutrients, N balance, rumen pH, ruminal NH_3-N and BUN.

3-4 Experimental procedure

3-4-1 Experiment No. (1):

The experiment was conducted from 20 April to 12 May (2005) lasting 23 days. The average daily maximum and minimum temperature were 46°C and 37°C respectively nine yearling uncastrated Nubian goats ranging in weight from 14 to 17 kg were used in this study. They were randomly allocated to three nutritional experimental treatments with 3 animals per treatment following the completely randomized design with 2x2 factorial arrangement of treatment.

The treatments were:

T_1-Adlibitum water and feed.

T_2-Adlibitum feed and restricted water to 50% from adlibitum.

T_3-adlibitum food and water restricted to 100% from adlibitum.

During the experiment, the animals were provided with alfalfa hay (*Medicago sativa*). Prior to the experiment fresh alfalfa were prepared by drying into hay and then chopped up and then roughly mixed before feeding. The detailed composition of feeds is shown in Table (2).

Table (2): Chemical composition as % of the experimental ration (alfalfa hay)*

Parameter	Alfalfa
Ash	20.21
Organic matter (OM)	85.78
Crude protein (CP)	15.22
Ether extract (EE)	1.79
Crude fibre (CF)	26.17
Nitrogen free extract (NFE)	42.58
DM	95.54

*on dry matter basis

Animals were handled and housed in similar manner as described before. Feeding and collection procedure and sample (feed, faeces, urine, rumen fluid and blood) analysis were conducted as explained before also data recording of RT and RR was similar to that described before.

The parameters investigated were DMI, WI, RT, RR, digestibility coefficients of the various nutrients, N-balance, rumen pH, ruminal NH_3-N and BUN.

3-4-2 Experiment No. (2):

The experiment was conducted from 16 December to 7 January (2006) lasting 22 days. The average daily maximum and minimum temperature 28°C and 21°C respectively.

Twelve yearling uncastrated male, of Nubian goats ranging in weight 11.5 to 17.5 kg were used in this study. The animals were left to acclimatize for 16 days, during which they were allocated at random to each of the experimental treatment in 2x2 factorial arrangements of treatments. The treatments will be referred to as follows:

T_1-adlibitum water and adlibitum feed (control).

T_2-adlibitum water feed restricted to 66.66% from adlib.

T_3-water restricted to 33.3% and feed restricted to 66.66% from adlib.

T_4: water restricted to 33.3% from adlib. and feed adlib.

During the experiment the animals were provided with alfalfa (*Medicago Sativa*) hay. Prior to the experiment fresh alfalfa were prepared by drying into hay and then chopped and thoroughly mixed before feeding.

The parameters investigated were:

Dry matter intake, WI, faecal DM output, urine volume, RT, RR, digestibility coefficients of the various nutrients, N-balance, rumen pH, ruminal NH_3-N and blood urea nitrogen.

Table (3): Chemical composition as % of experimental ration (alfalfa) experiment (2)*

Parameter	Alfalfa
Ash	13.23
Organic matter (OM)	85.3
Crude protein (CP)	15.05
Ether extract (EE)	1.9
Crude fibre (CF)	25.54
Nitrogen free extract (NFE)	42.50
Dry matter	97.34

*on dry matter basis

Animals were handled and housed in a similar manner as described before. Feeding and collection procedure and sample (feed, faeces, urine, rumen fluid and blood) analysis were conducted as explained before, also data recording of RT and RR were similar to those described before.

3-4-3 Experiment No (3):

The experiment was conducted from 15 March to 6 April (2006) lasting to 22 days. The average daily maximum and minimum temperature were 46°C and 35°C respectively. Twelve yearling uncastrated males of Nubian goats weighing 13 to 17 kg were used in this experiment.

The animals were randomly allocated to one of the two types of feed (alfalfa hay or Abu70) to two water regimes with three animals per treatment following the completely randomized design with a 2x2 factorial arrangement of treatments.

The treatments were:

T_1-adlibitum alfalfa hay water every 24 hrs.

T_2-adlibitum Abu70 hay water every 24 hrs.

T_3-adlibitum alfalfa hay water every 48 hrs.

T_4: adlibitum Abu70 hay water every 48 hrs.

During the experiment, the animals were provided with alfalfa hay (*Medicago sativa*) or Abu70 hay (*sorghum vulgare*) prior to the experiment fresh alfalfa were prepared by drying into hay and then chopped and thoroughly mixed before feeding, also abu 70 hay was drying, chopped and thoroughly mixed before feeding.

Table (4): Chemical composition as % of ration (alfalfa) hay and (Abu 70) hay experiment (3)*

Parameter	Alfalfa hay	Abu70
Ash	18.00	13.52
Organic matter (OM)	82.00	86.48
Crude protein (CP)	20.13	6.83
Ether extract (EE)	1.50	1.30
Crude fibre (CF)	23.45	28.50
Nitrogen free extract (NFE)	36.93	49.86
Dry matter	96.04	96.35

* on dry matter basis

Animals were handled and housed in a similar manner as described before. Feeding and collection procedure and sample (feed, faeces, urine, rumen fluid and blood) analysis were conducted as explained before. Data recording of RT and RR were similar to those described before.

The parameters investigated were DMI, WI, urine volume, RT, RR digestibility coefficients of the various nutrients, N-balance, rumen pH, ruminal NH_3-N and blood urea nitrogen.

3-4-4 Experiment No. (4):

The experiment was conducted from 7 July to 7 September (2006) lasting to 31 days. The average maximum and minimum temperature were 41°C and 33°C respectively.

Six yearling uncastrated males of Nubian goats weighing 13-15 kg were used in this experiment. They were randomly allocated to one of the three experimental nutritional treatments with two animals per treatment in a 3x3 Latin square design.

The treatments were:

T_1-Adlibitum water and feed (control).

T_2- water restricted to 33.3% from adlib. and feed adlib.

T_3-water adlib. and feed restricted to 33.3% from adlib.

The animals were interchanged between the treatments so that each of the six animals was employed in each treatment.

The animals were provided with alfalfa hay which was treated in a same manner as explained before the chemical composition of alfalfa hay of the three periods are shown in table (5).

Table (5): Chemical composition as % of the experimental ration (alfalfa hay) of three periods experiment (4)*

Parameter	Period (1)	Period (2)	Period (3)
Ash	11.91	10.89	10.45
Organic matter (OM)	85.08	85.10	86.54
Crude protein (CP)	16.53	16.10	15.57
Ether extract (EE)	2.07	1.58	1.29
Crude fibre (CF)	23.25	26.91	27.66
Nitrogen free extract (NFE)	43.21	41.50	43.01
Dry matter	95.27	95.47	96.20

* on dry matter basis:

Animals were handled and housed in a similar manner as described before feeding and collection procedures and sample (feed, faeces, urine, rumen fluid and blood) analysis were conducted as explained before data recording of RT and RR was similar to that described before.

The parameters investigated were:

Dry matter intake, WI, urine volume, RT, RR, digestibility coefficients of the various nutrients, N-balance, rumen pH ruminal NH_3-N and blood urea nitrogen.

3-5 Statistical Analysis

Analysis of variance (ANOVA) was used to determine the treatment effects. Duncan multiple range tests were used to rank treatment means (Mead and Curnow, 1983).

Chapter four

4. Results and Discussion

4-1 Experiment No (1)

4-1-1 Effect of water restriction on DMI, WI, WI: DM ratio, faecal DM output, urine volume, RT and RR:

The effect of water restriction on DMI, WI, WI: DMI ratio faecal DM output, urine volume, RT and RR is shown in table (6).

Dry matter intake (DMI), WI, WI: DMI ratio RT and RR are significantly ($P<0.05$) affected by water restriction whereas faecal DM output and urine volume are not affected. DMI decreased by 100% water restriction than 50% and control similar results were obtained by Ahmed (1989) who said that restrictions of water intake to 40% of adlibitum level significantly lowered DMI, this finding was reported by other workers for sheep (Howard, 1972) and steers (Ikhatua *et al*., 1985) also similar results were obtained in desert goats when water was restricted to 40% (Ahmed and Elshafei, 2001). On the other hand, (Casamassima *et al*., 2008) found no significant effect of water restriction on feed intake, when Comisana sheep were subjected to water restriction (60% and 80% of adlibitum intake) also (Hassouna; 2012) said that water restriction failed to induce a significant ($P>0.05$) effect on DMI, faecal DM output urine volume, RT and RR. In this study when water was restricted to 100% the animals reduced their food intake by about 50% for the 3 first days this online with (Khan *et al*., 1978) who found that when Barme goats were subjected to 4 days of water restriction the voluntary feed intake was reduced by 40%, while Gordon (1965) noted that in housed sheep the reduction in feed intake was 46% for the same period of water deprivation. In this study after 4 days of water deprivation there was a dramatic fall in the voluntary intake and the animals nearly stopped eating about 99% decrease in the feed intake this result was on line with (Ghosh and Khan, 1978) who used Marwari sheep to the same period of deprivation. After 5 days of restriction the animals in the present study stopped eating, stopped movement and one of the three animals used died.

The ratio of WI:DMI was significantly (P<0.05) higher when the animals had adlibitum water intake and lowered significantly when water was restricted to about 50% from adlibitum similar results were obtained by (Hassouna, 2012) who said that WI: DMI ratio was highly significantly (P<0.01) higher when animals (sheep and goats) had adlibitum access to water, also (Ajibola, 2006) in goats subjected to water restriction (30%, 50% and 100% of the adlibitum) (Alamer, 2009) found that a significant decrease in WI to feed intake ratio with 50% and 25% water restriction in goats.

Faecal DM output was affected insignificantly by water restriction and also urine volume was decrease by water restriction also (Ahmed and Abdelatif, 1992) obtained the same results that water restriction decreased faecal output and urine volume when they used desert rams.

Rectal temperature and RR were significantly (P<0.05) affected by water restriction. RT in this study increased by water restriction also RR was increased significantly by 50% restriction. This finding confirms that obtained by Seri *et al*. (2009) who said that water restriction causes an increase in RT and RR in sheep also this in line with the finding obtained by (Hassouna, 2012) who said that water restriction increased RT and

RR when used Nubian goats and desert sheep as affected by 50% water restriction. In this study 100% restriction showed slight decrease in RR this finding on line with (Ahmed and Abdelatif, 1993) who said that when used desert rams, water was restricted slightly decrease RT and significantly decreased RR, but they said also in the same study that RT and RR were increased significantly in the afternoon when the mean ambient temperature was high.

Table (6): Effect of water restriction on dry matter intake (DMI), water intake (WI), WI:DMI ratio, faecal dry matter (DM) output, urine volume, rectal temperature (RT) and respiratory rate (RR) in Nubian goats

Parameter	Treatments*			Sig.
	T_1	T_2	T_3	
DMI (kg/day)	0.91±0.04[a]	0.95±0.04[a]	0.65±0.09[b]	0.0018
Water intake (kg/day)	3.29±0.08[a]	1.51±0.37[b]	0.00±0.00[c]	1.3081
Water intake: DMI	3.60±0.21[a]	1.59±0.36[b]	0.00±0.00[c]	1.4752
Faecal DM(kg/day) output	0.29±0.01[a]	0.31±0.07[a]	0.21±0.06[a]	0.14101
Urine volume(cm^3)	498.30±168.89[a]	328.30±157.12[a]	262.20±29.27[a]	0.1650
RT (°C)	38.45±0.02[b]	38.67±0.30[ab]	38.95±0.15[a]	0.0085
RR (breath/min)	37.67±3.05[b]	39.67±6.51[a]	33.67±2.08[c]	1.3464

Key:

T_1 ≡ Feed and water adlib (Control).

T_2 ≡ Feed *adlib*-water 50% from *adlib*

T_3 ≡ Feed *adlib*-water 100% restriction

* Values are means ±SD of three animals

* Values in the same row bearing same superscripts are not significantly different (P>0.05).

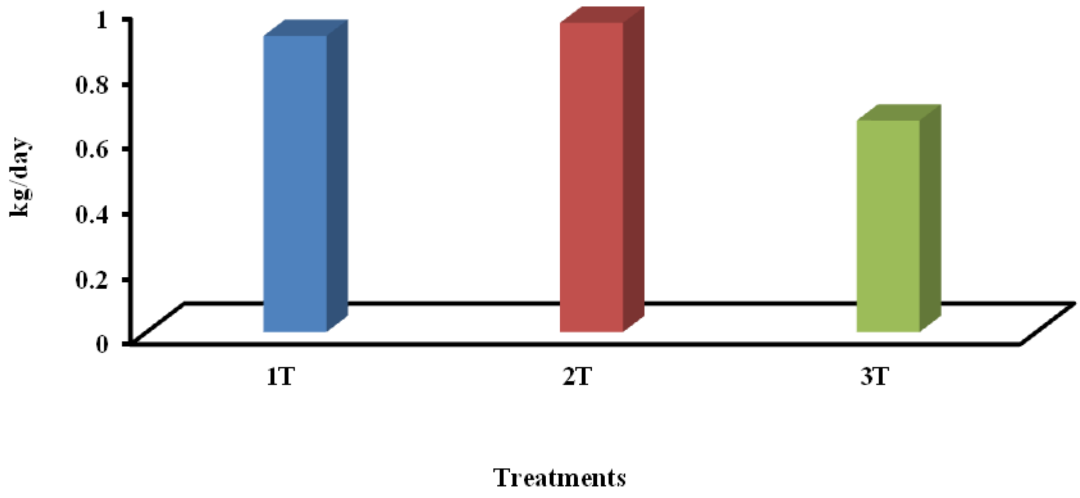

Fig. (1): DMI (Exp. I)

DMI≡Dry matter intake

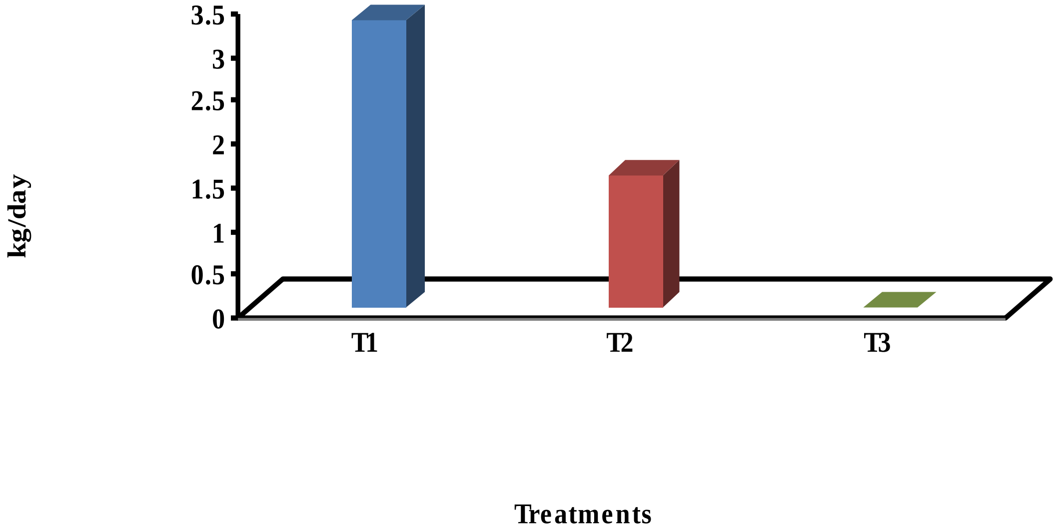

Fig. (2): WI (Exp. I)

WI≡Water intake

<u>Key</u>

T_1 ≡ Control feed and water

T_2 ≡ Feed *adlib*-water 50% from *adlib*

T_3 ≡ Feed *adlib*-water 100% restriction

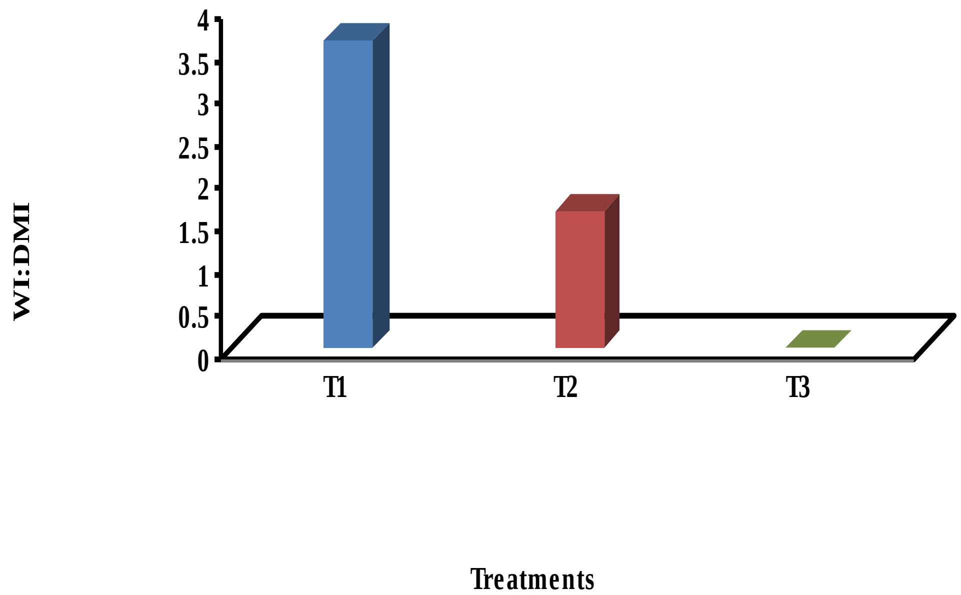

Fig. (3): WI:DMI ratio (Exp. I)

Water intake **:** Dry matter intake ratio

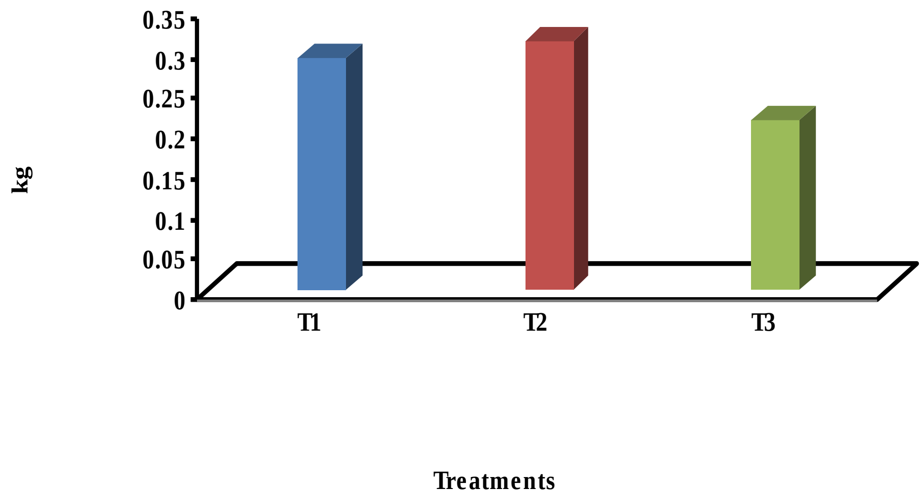

Fig. (4): Faecal DMI output (Exp. I)

Faecal dry matter output

<u>Key</u>

T_1 ≡ Control feed and water

T_2 ≡ Feed *adlib*-water 50% from *adlib*

T_3 ≡ Feed *adlib*-water 100% restriction

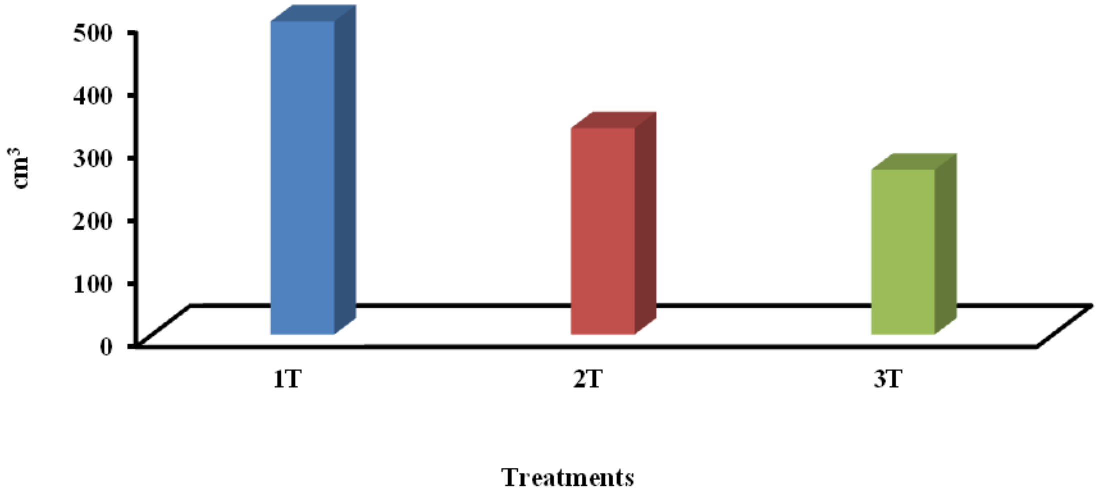

Fig. (5): Urine volume (Exp. I)

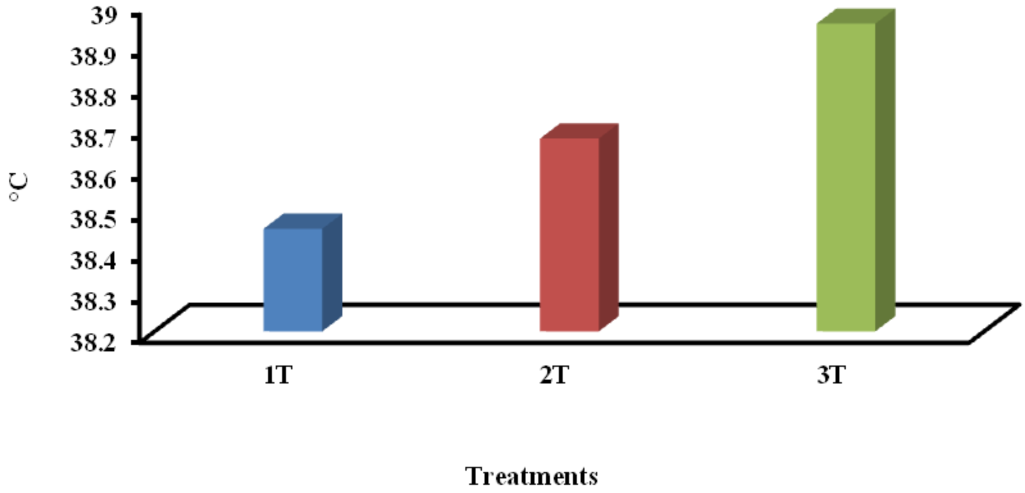

Fig. (6): RT (Exp. I)

Rectal temperature

Key

T_1 ≡ Control feed and water
T_2 ≡ Feed *adlib*-water 50% from *adlib*
T_3 ≡ Feed *adlib*-water 100% restriction

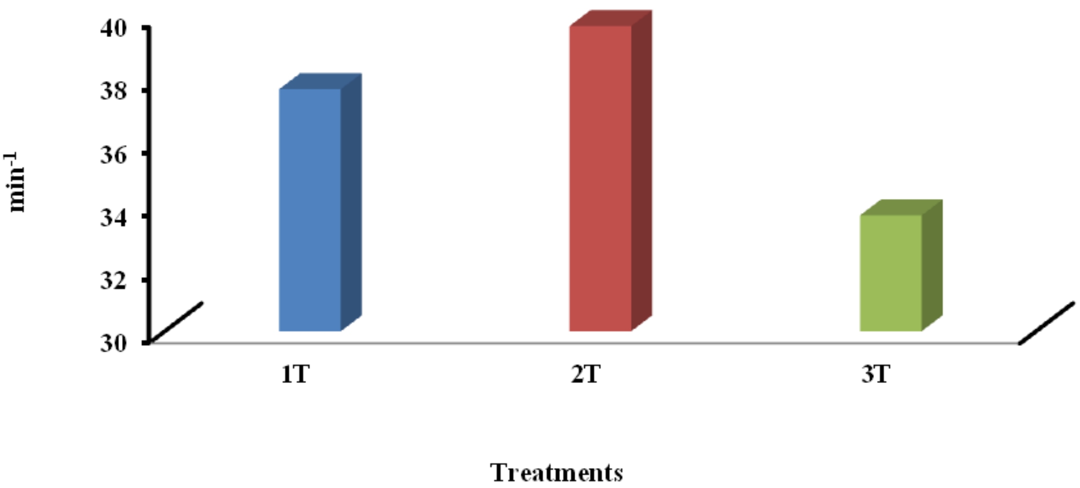

Fig. (7): RR (Exp. I)

Respiratory rate

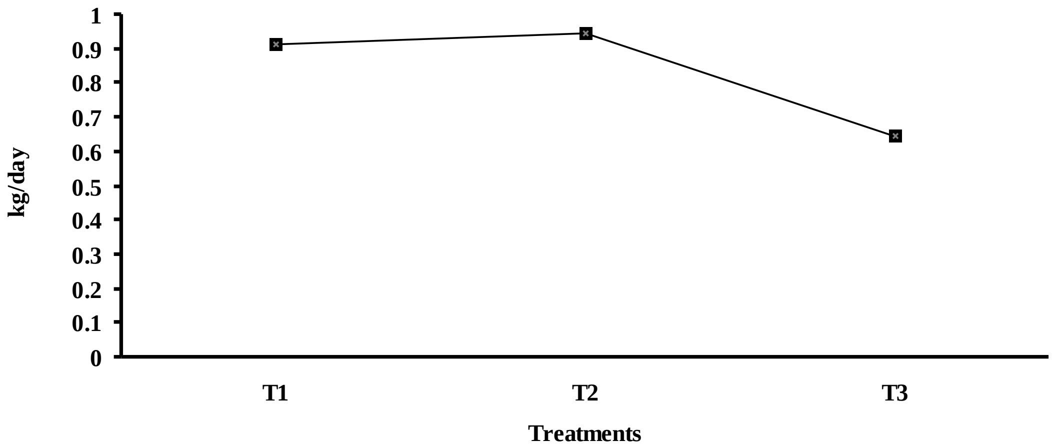

Fig. (8): DMI (exp.1)

Dry matter intake

Key

T_1 ≡ Control feed and water

T_2 ≡ Feed *adlib*-water 50% from *adlib*

T_3 ≡ Feed *adlib*-water 100% restriction

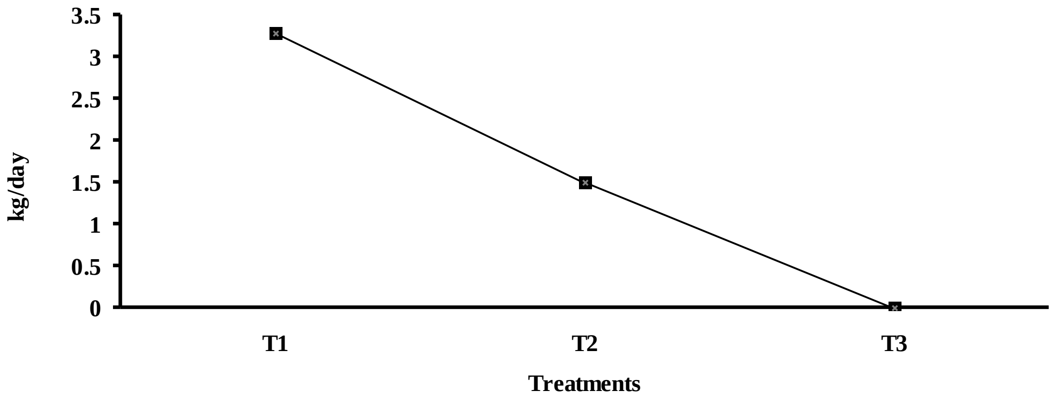

Fig. (9): WI (exp.1)

Water intake

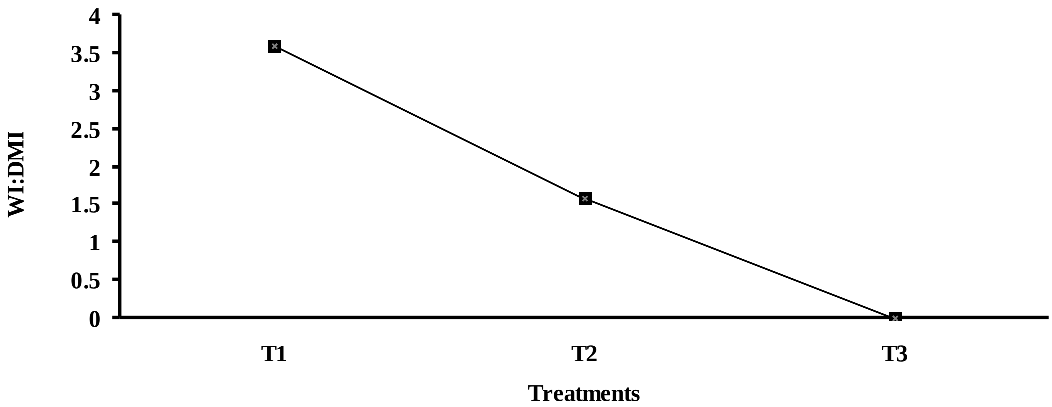

Fig. (10): WI:DMI ratio (exp.1)

Water intake **:** Dry matter intake ratio

Key

T_1 ≡ Control feed and water

T_2 ≡ Feed *adlib*-water 50% from *adlib*

T_3 ≡ Feed *adlib*-water 100% restriction

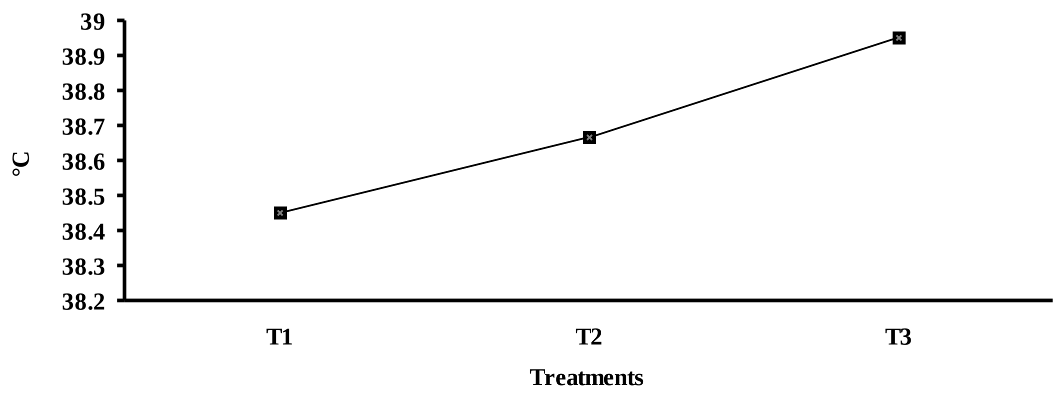

Fig. (11): RT (exp.1)

Dry matter intake

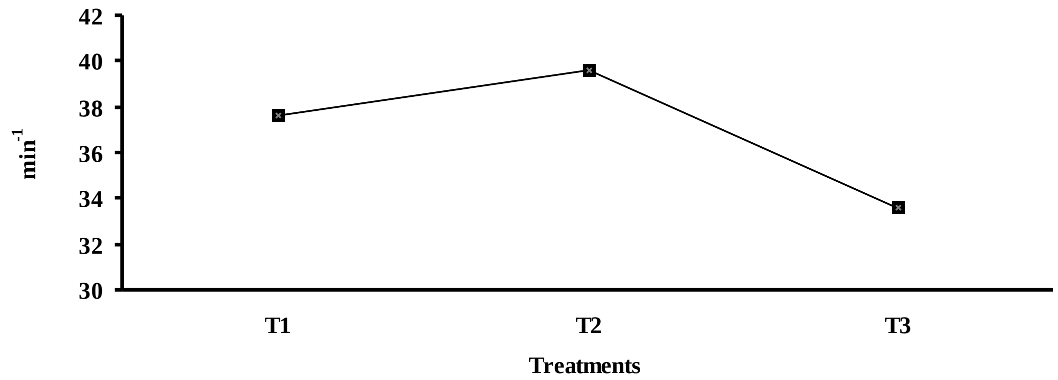

Fig. (12): RR (exp.1)

Respiratory rate

Key

T_1 ≡ Control feed and water

T_2 ≡ Feed *adlib*-water 50% from *adlib*

T_3 ≡ Feed *adlib*-water 100% restriction

4-1-2 Apparent digestibility coefficients as affected by water restriction:

The effect of water restriction on the apparent digestibility coefficients of nutrients in Nubian goats are shown in table (7).

Water restriction had no significant effect on DMD, OMD and CPD, but EED showed a significant ($P<0.05$) increase with 50% restriction and a significant ($P<0.05$) decrease in 100% restriction Osman and Fadlalla (1974) reported a significant ($P<0.05$) reduction with water restriction likewise Hassouna (2012) showed that EED was numerically reduced with water restriction.

The reduction in nutrient digestibility coefficients can be attributed to the low level of nutrients in the diet, CFD and TDN showed a significant ($P<0.05$) decreased from the control. A similar study conducted by Ahmed and Elshafei (2001) revealed that TDN was significantly ($P<0.05$) affected by water restriction in desert goats fed Lucerne hay. NFED showed a significant ($P<0.05$) decrease with 100% restriction while 50% restriction showed no significant ($P>0.05$) effect on the contrary results obtained by (Osman and Fadlalah, 1974) who said that NFED increased with water restriction to about 50%.

Similar results were obtained by several researchers that they failed to find a significant increase in nutrient digestibility with water restriction as in sheep (Ahmed and Abdelatif, 1994; Hadjigeorgiou *et al*., 2000) and goats (Silanikove, 1987, Lutfi and Ahmed 2010).

Table (7): Effect of water restriction on apparent digestibility coefficients of nutrients in Nubian goats:

Parameter	Treatments*			Sig.
	T_1	T_2	T_3	
DMD	77.79±3.79[a]	76.04±4.87[a]	74.32±8.49[a]	0.123
OMD	78.46±3.35[a]	77.50±4.74[a]	75.93±8.51[a]	0.6945
CPD	84.96±2.60[a]	83.50±2.04[a]	81.41±5.92[a]	0.7116
EED	44.58±10.18[b]	48.37±15.73[a]	36.90±23.67[c]	0.0014
CFD	76.36±4.28[a]	74.94±5.86[b]	75.06±7.56[b]	0.0026
NFED	78.72±2.87[a]	78.12±5.02[a]	76.15±9.32[b]	0.0071
TDN	71.40±3.17[a]	70.68±4.64[a]	69.01±8.17[b]	0.0048

Key:

T_1 ≡ Feed and water adlib (Control).

T_2 ≡ Feed *adlib*-water 50% from *adlib*

T_3 ≡ Feed *adlib*-water 100% restriction

* Values are means ±SD of three animals

* Values in the same row bearing same superscripts are not significant different (P>0.05).

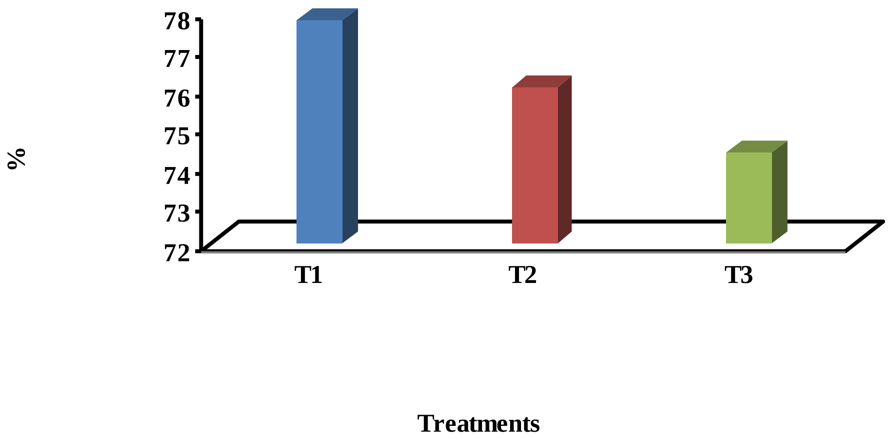

Fig. (13): DMD (Exp. I)

Dry matter digestibility

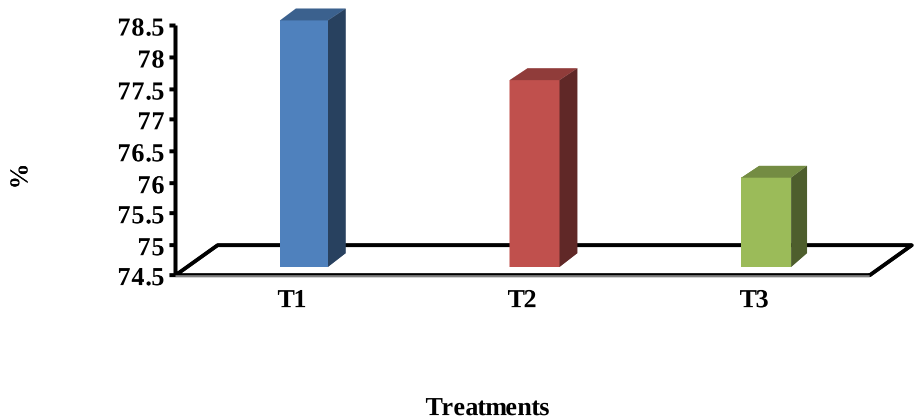

Fig. (14): OMD (Exp. I)

Organic matter digestibility

Key

T_1 ≡ Control feed and water
T_2 ≡ Feed *adlib*-water 50% from *adlib*
T_3 ≡ Feed *adlib*-water 100% restriction

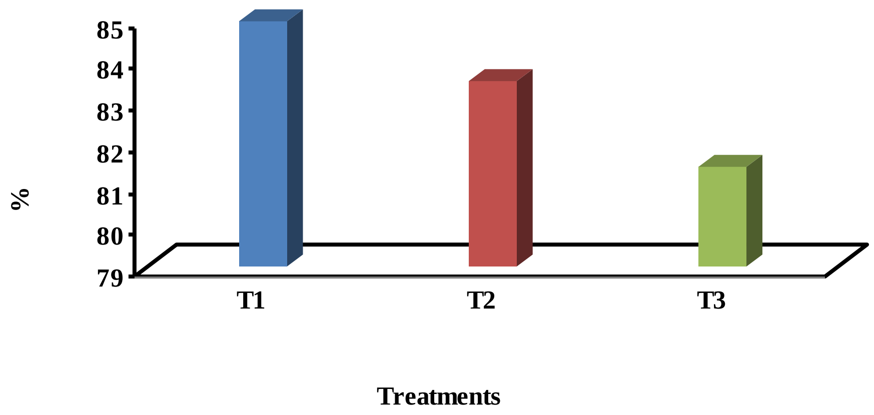

Fig. (15): CPD (Exp. I)

Crude protein digestibility

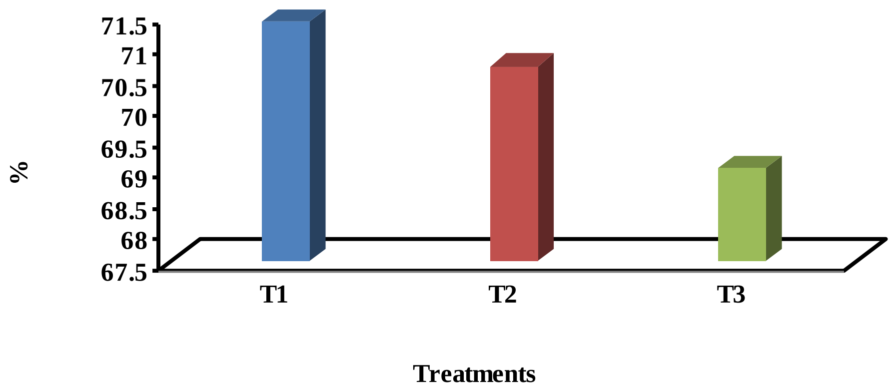

Fig. (16): TDN (Exp. I)

Total digestible nutrients

Key

T_1 ≡ Control feed and water

T_2 ≡ Feed *adlib*-water 50% from *adlib*

T_3 ≡ Feed *adlib*-water 100% restriction

4.1.3 Effect of water restriction on rumen fermentation products and blood urea nitrogen

The effect of water restriction on rumen fermentation products and BUN are shown in table (8).

Water restriction had no significant (P>0.05) effect on ruminal pH and BUN. Our results was on line with (Hassouna (2012) who reported that water restriction had no significant effect on ruminal pH and these results were contrary to the finding of Ahmed (1987) and Ahmed and Abdelatif (1994) who reported that water restriction significantly decreased pH. They attributed this reduction to reduction in fluidity of rumen contents and reduced salivary secretion and increase in the concentration of VFA. NH_3-N in our study was not affected by water restriction and this result is in line with Toha *et al*., (1989) and Ahmed and Abdelatif (1994) who found that rumen NH_3-N concentrations were not affected significantly (P>0.05) by water restriction. In contrast with these results (Hassouna, 2012) who reported that there was highly significant (P<0.01) decrease of rumen ammonia with water restriction. pH and NH_3-N obtained in this study were not significantly affected by sampling time and these results was in contrast Lutfi and Ahmed (2010) who said that sampling time was affected pH and NH_3-N.

Water restriction did not affect (P>0.05) significantly BUN in this study confirms the results obtained by (Hassouna 2012, Glosh *et al*., 1983; Kheir and Ahmed, 2008; Lutfi and Ahmed, 2010) while (Ahmed and Abdelatif, 1994; Burgos *et al*., 2001) said that BUN increased with water restriction. The increase in BUN is due to the greater water uptake to kidney and to the decreased blood flow towards the urinary apparatus that causes a reduction of urine and the increase of BUN concentration (Casmassima *et al*., 2008).

Table (8): Effect of water restriction and sampling time on rumen pH, ruminal ammonia nitrogen (NH_3-N) and blood urea nitrogen (BUN) in Nubian goats:

Parameter	Treatments*			Sig.
	T_1	T_2	T_3	
pH				
Before feeding	6.05±0.57[a]	6.93±0.45[a]	6.09±0.54[a]	0.1467
3 hrs after feeding	6.53±0.19[a]	6.56±0.34[a]	6.30±0.22[a]	0.1986
6 hrs after feeding	7.03±0.42[a]	7.16±0.28[a]	7.13±0.22[a]	0.2066
NH_3 (mg/100 ml rumen liquor)				
Before feeding	7.06±1.21[a]	5.18±1.98[a]	5.20±1.14[a]	0.2833
3 hrs after feeding	9.52±0.01[a]	7.93±1.54[a]	9.59±2.59[a]	0.1854
6 hrs after feeding	7.56±1.28[a]	7.37±1.06[a]	9.99±1.97[a]	0.1327
BUN (mg/100 ml blood)				
Before feeding	39.49±7.36[a]	31.47±9.65[a]	42.76±9.19[a]	0.3369
3 hrs after feeding	34.43±3.20[a]	35.22±10.08[a]	42.63±7.49[a]	0.3932
6 hrs after feeding	41.46±6.24[a]	34.79±20.95[a]	40.68±14.72[a]	0.3084

Key:

T_1 ≡ Feed and water adlib (control).

T_2 ≡ Feed *adlib*-water 50% from *adlib*

T_3 ≡ Feed *adlib*-water 100% restriction

*Values are means ± SD of three animals.

* Values in the same row bearing same superscripts are not significantly different (P>0.05).

4.1.4 N-balance as affected by water restriction

The effect of water restriction on nitrogen N-balance in Nubian goats is shown in table (9).

Water restriction obtained a highly significant (P<0.01) effect on N-balance and N intake whereas faecal-N urinary-N, were not affected significantly by water restriction. Similar results were obtained by (Hassouna, 2012) who said that NB was increased by water restriction also (Walt *et al*., 1999) who reported that inadequate drinking leads to decreased N excretion and improved N retention.

Ahmed and ElShafei (2001) found also an increase in N retention with water restriction also (Mousa and Elkalifa, 1992) said that NB was significantly (P<0.05) improved in kids and lambs when deprived water for 5 days. faecal and urinary N was insignificantly reduced by 50% and 100% water restriction similar results obtained by (Mousa and Elkalifa, 1992) who said that urinary and faecal N was significantly reduced (P<0.05) in lambs when water was offered for 5 days also the same results obtained by (Ahmed, 1989) when water was restricted to 40% of adlibitum in desert rams Hassouna (2012) obtained the same results when used desert sheep and Nubian goats. NB was in positive values that mean N was sufficient to meet the requirements of the animal.

Table (9): Effect of water restriction on nitrogen N-balance in Nubian goats

Parameter	Treatments			Sig.
	T_1	T_2	T_3	
N-intake (g/day)	21.26±0.98[a]	22.05±0.94[a]	15.10±2.04[b]	0.0018
Faecal-N (g/day)	3.19±0.64[a]	3.66±0.37[a]	2.81±0.76[a]	0.3081
Urinary-N (g/day)	7.64±1.97[a]	6.85±2.51[a]	6.48±0.63[a]	0.4752
N-balance (g/day)	10.60±2.03[ab]	11.54±2.79[a]	5.81±2.51[b]	0.0059
NB as % of N-intake	50.06±10.54[a]	52.36±12.32[a]	37.71±13.37[a]	0.3481
NB as % of digested-N	58.70±10.90[a]	62.64±13.48[a]	45.85±13.94[a]	0.3464

Key:

T_1 ≡ (Control) adlib_ feed and water.

T_2 ≡ Feed *adlib*-water 50% from *adlib*.

T_3 ≡ Feed *adlib*-water 100% restriction

* Values are means ±SD of three animals

* Values in the same row bearing same superscripts are not significantly different (P>0.05).

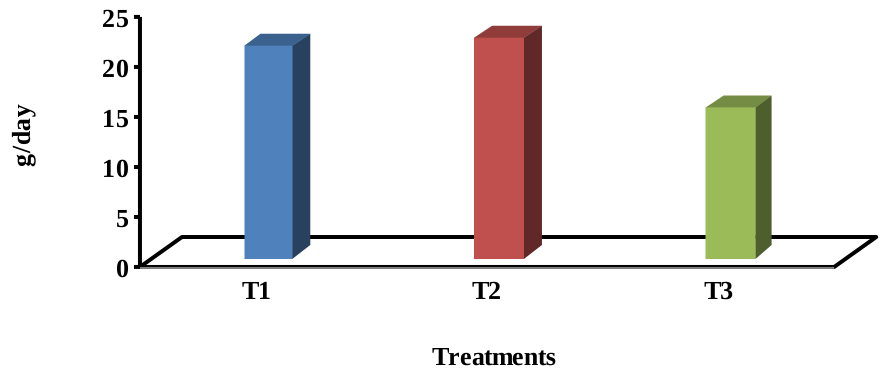

Fig. (17): N-intake (Exp. I)

Nitrogen intake

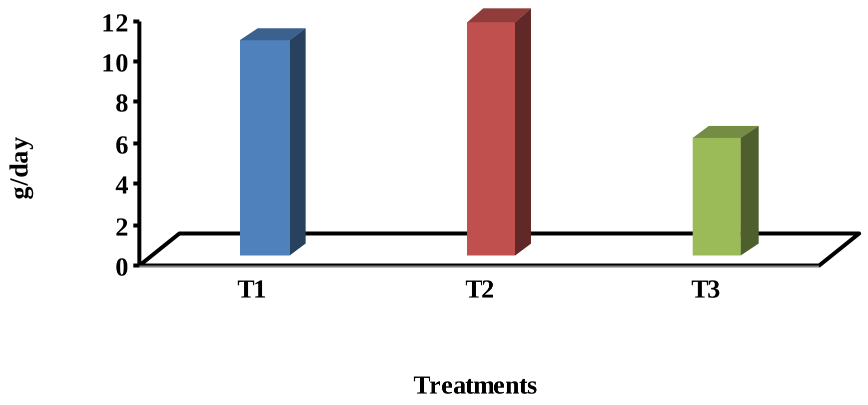

Fig. (18): N-balance (Exp. I)

Nitrogen balance

Key

T_1 ≡ Control feed and water

T_2 ≡ Feed *adlib*-water 50% from *adlib*

T_3 ≡ Feed *adlib*-water 100% restriction

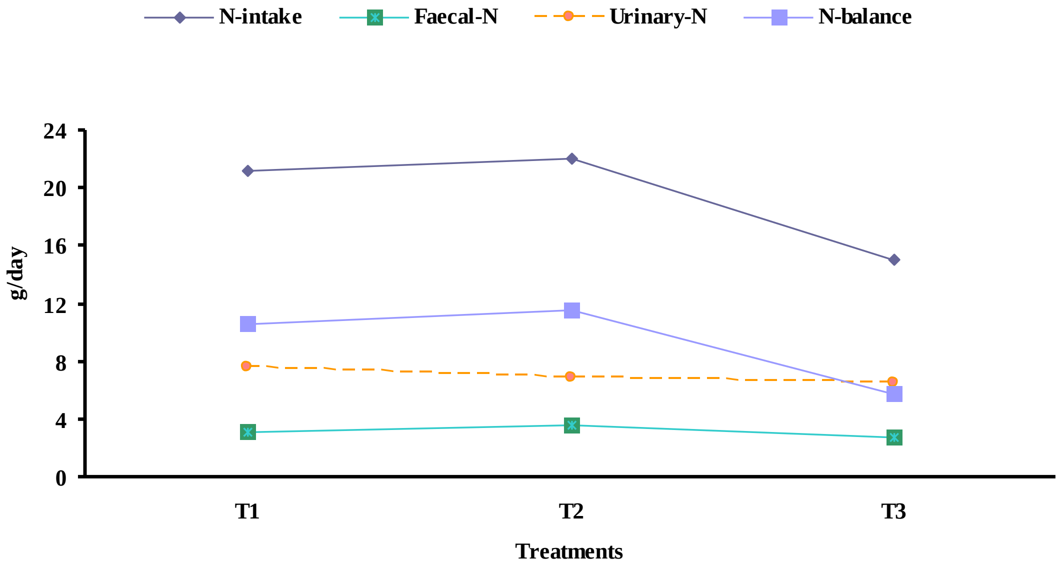

Fig. (19): NB (Exp.1)

Nitrogen balance

Key

T_1 ≡ Control feed and water

T_2 ≡ Feed *adlib*-water 50% from *adlib*

T_3 ≡ Feed *adlib*-water 100% restriction

4-2 Experiment No. 2:

4.2.1 Effect of feed and water restriction on DMI, WI, WI: DMI ratio, faecal DM output, urine volume, RT and RR

The effect of water and food restriction on DMI WI, WI: DMI ratio faecal DM output, urine volume, RT and RR in Nubian goats are shown in table (10). DMI, WI, urine volume and faeces DM output are significantly ($P<0.05$) affected by treatments whereby RT and RR were not affected ($P>0.05$) by treatments DMI decreased significantly ($P<0.05$) by feed restriction, water and feed restriction, and water restriction compared to adlib feed and water on line with these results Ahmed and Abdelatif (1993) stated that restriction of water intake significantly reduced both DMI and the ratio of WI: DMI. Ahmed (2009) reported that DMI was lower with feed restriction as compared to water restriction. Also (Ahmed, 1989) reported that reduction of water intake to 40% of adlibitum level significantly lowered DMI by 40% whereas reduction of DMI to 68% of adlibitum level significantly reduced water consumption by 36%.

This linkage is attributed to the essential role of water in the process of digestion and elimination of waste products of metabolism (Phillips, 1960) Hassouna (2012) found that feed restriction (33.33% of the adlibitum intake) significantly ($P<0.05$) affected DMI, WI, WI: DMI ratio, faecal DM output, urine volume and RT in Nubian goats and desert sheep fed on Abu 70 hay. WI was higher in feed restriction compared to water restriction and adlibitum feed and water (control), contrary Teixeira *et al*., (2006) found that WI in goats fed at 30% level of intake decreased significantly compared with adlibitum intake of feed.WI: DMI ratio significantly affected by treatments, The ratio was increased by feed restriction and decreased by water and feed restriction and water restriction, Ahmed (1989) also found that reduction of water intake significantly lowered this ratio. Many researchers obtained the same results, Hassouna (2012). Rossi *et al*., (1999) Ahmed and Abdelatif (1994) and Ahmed and Elshafie (2001) in sheep and goats subjected to feed restriction, also many workers in water restriction obtained the same results, Hassouna (2012) in sheep and Nubian goats Ajibola (2006) in goats, Alamer (2009) in goats. Faecal DM output was affected by water restriction, water and feed restriction and feed restriction they were decreased compared to adlib water and adlib feed. These results were in line with Ahmed (2009) who reported a significant decreased of faecal DM output as a result of 50% restriction of water and 50% restriction of feed when used Nubian goats Ahmed and Abdelatif (1994) reported a decreased in faecal DM output in adults desert rams subjected to feed and water restriction. Urine volume was affected significantly with feed restriction compared to adlib feed and water, urine volume was increased significantly with feed restriction and decreased insignificantly with water restriction Ahmed (1989) and Ahmed and Abdelatif (1993) found that water restriction decreased urine volume. This would illustrate a tendency to conserve body water during periods of water scarcity.

Where by Hassouna (2012) and Teixeira *et al*. (2006) reported an increase in urine volume with feed restriction in goats subjected to 66.66% and 60% feed restriction respectively compared to the adlib level of feed, in their study, the increase in urine volume was significant. There was a linear relationship between water intake and water loss through urine (Teixeira *et al*., 2006) and this was in agreement with the present study. RT and RR showed no significant effect with the treatments on lines with our results (Hassouna, 2012) Lutfi and Ahmed (2010), and Ahmed (2009) observed insignificant (P>0.05) difference in RR in food restriction but contrary to this finding (Ahmed and Elkheir (2004), and Ahmed and Abdelatif (1994) who found that respiratory rate RR decreased with food restriction Kheir and Ahmed (2008) reported that (RR) was higher ($P<0.05$) due to water restriction in animals fed Lucrene hay, the same results obtained by Ahmed and Abdelatif (1994) who found that RR was significantly decreased by both water and feed restriction, but it was increased significantly in the afternoon when the mean ambient temperature was high also Ahmed (1989) reported that RR deceased significantly with both water and feed restriction during the morning and the afternoon, this would indicate a general decline in metabolism.

Abdalla *et al*. (2010) reported a significant increase ($P<0.05$) in RT with water restriction, whereby Kheir and Ahmed (2008) reported that RT of goats restricted to feeding had low temperature both in the morning and afternoon 38.3°C and 39.01°C respectively.

Table (10): The effect of water and feed restriction on the dry matter intake (DMI), WI, WI: DMI ratio, Faecal dry matter output, Urine volume, rectal temperature (RT) and respiratory rate (RR) in Nubian goats:

Parameter	Treatments				Sig.
	T_1	**T_2**	**T_3**	**T_4**	
DMI (kg/day)	0.82±0.01[a]	0 .55±0.06[b]	0.54±0.07[b]	0.62±0.01[b]	0.0002
Water intake(kg/day)	1.93±0.08[a]	2.17±0.39[a]	0.46±0.02[b]	0.45±0.02[b]	0.8371
WI: DMI ratio	2.36±0.12[ab]	3.97±.94[a]	0.87±0.14[b]	0.72±0.04[b]	0.6254
Faecal DM (kg/day) output	0.30±0.02[a]	0.20±0.03[b]	0.20±0.04[b]	0.21±0.01[b]	0.0059
Urine volume (cm^3)	34.40±404.77[a]	365.50±23.03[a]	240.60±87.66[b]	203.10±44.05[b]	0.0123
RT (°C)	37.79±0.32[a]	37.36±0.25[a]	36.65±2.62[a]	38.28±0.25[a]	03840
RR (breath/min)	21.00±0.00[a]	21. ±1.00[a]	22.33±1.53[a]	22.33±0.58[a]	0.5245

Key:

T_1 ≡ Water *adlib* feed *adlib (control)*

T2≡Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

* Values are means ±SD of three animals

* Values in the same row bearing same superscripts are not significant different (P>0.05).

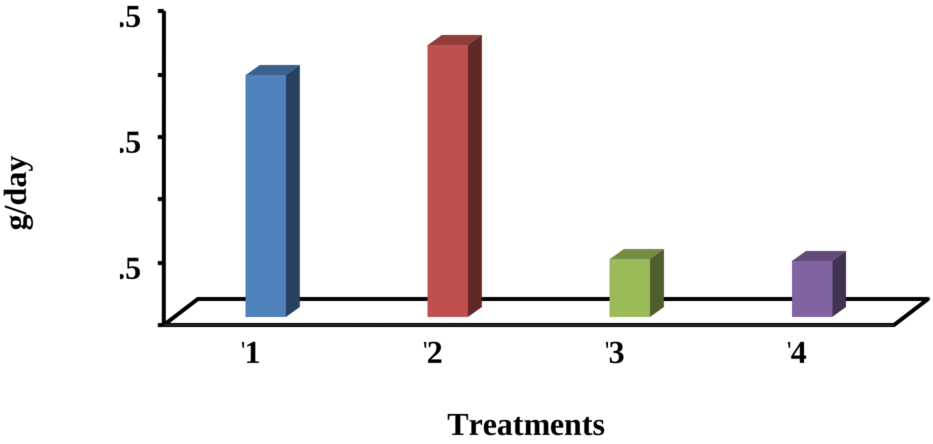

Fig. (20): WI (Exp. II)

Water intake

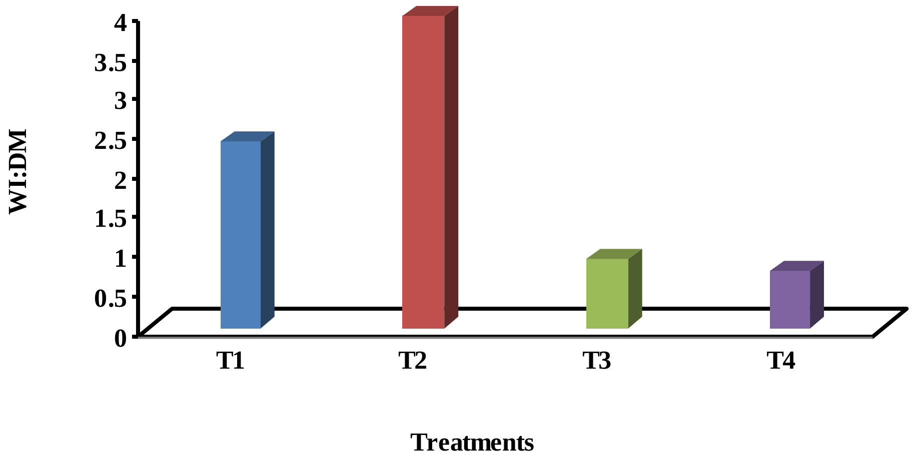

Fig. (21): WI:DM ratio (Exp. II)

Water intake **:** Dry matter ratio

Key:

T_1 ≡ Water *adlib* feed *adlib (control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

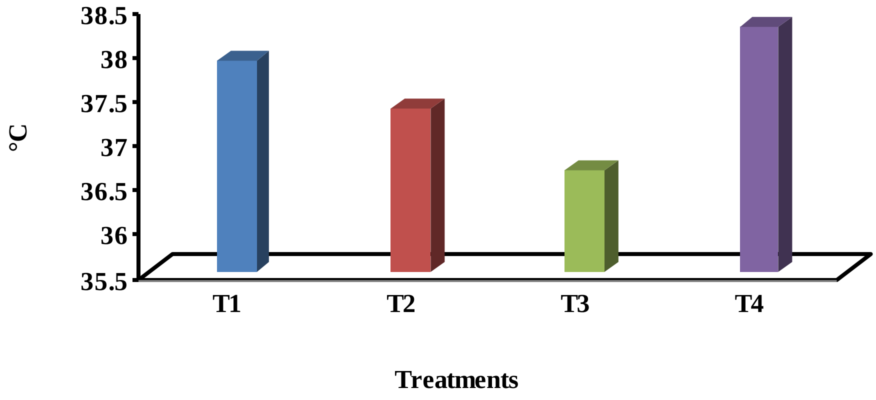

Fig. (22): RT (Exp. II)

Rectal temperature

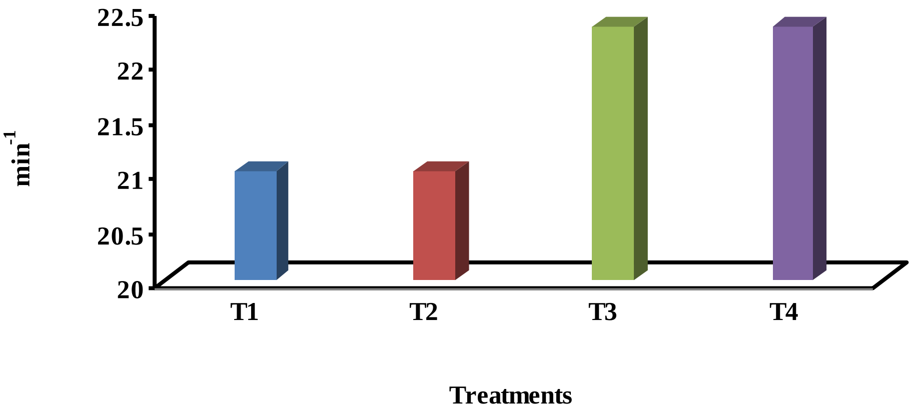

Fig. (23): RR (Exp. II)

Respiratory rate

Key:

T_1 ≡ Water *adlib* feed *adlib (control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

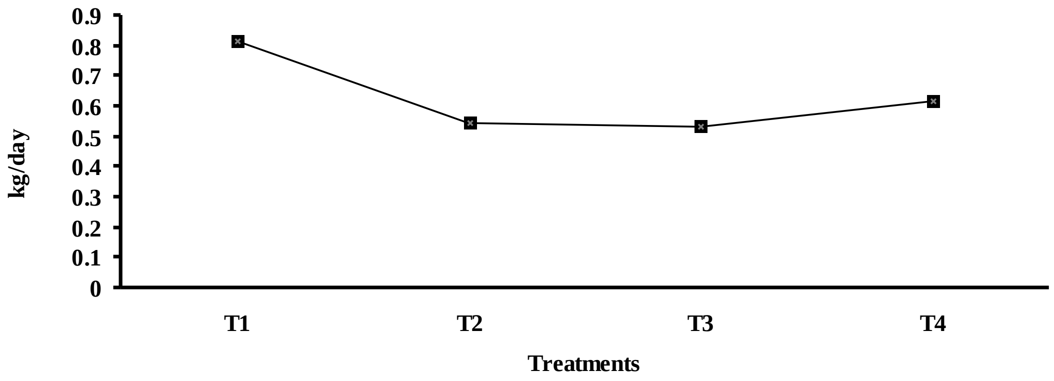

Fig. (24): DMI (Exp. II)

Dry matter intake

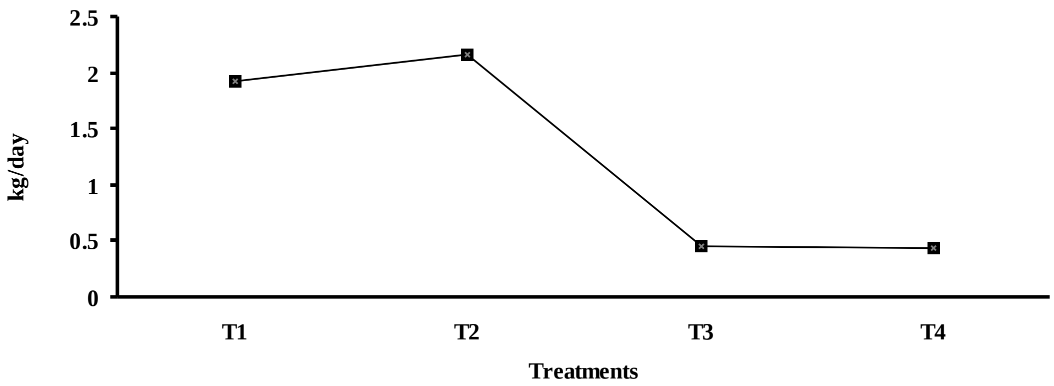

Fig. (25): WI (Exp. II)

Water intake

Key:

T_1 ≡ Water *adlib* feed *adlib (control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

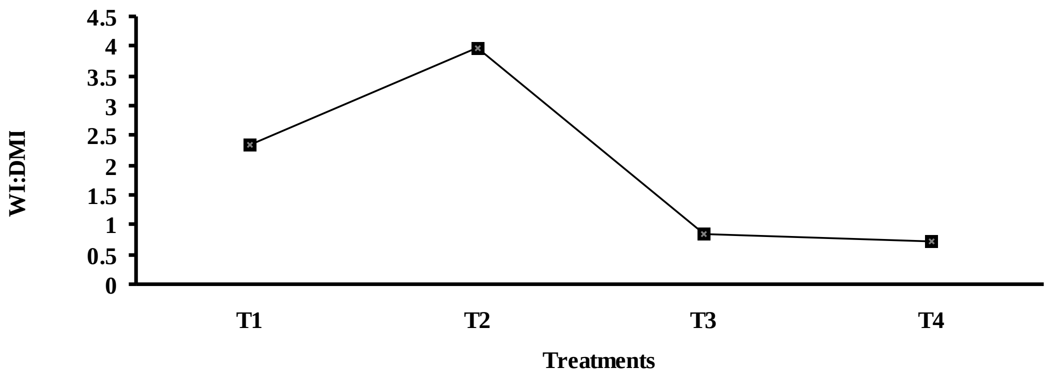

Fig. (26): WI:DMI ratio (Exp. II)

Water intake **:** Dry matter intake ratio

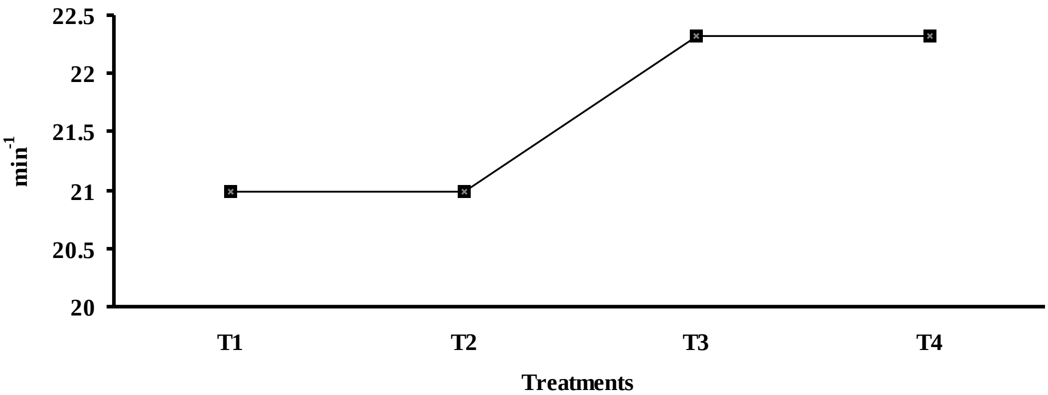

Fig. (27): RR (Exp. II)

Respiratory rate

Key:

T_1 ≡ Water *adlib* feed *adlib (control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

4.2.2 Effect of feed and water restriction on the digestibility coefficients of nutrients

The effect of water and feed restriction on the apparent digestibility coefficients of nutrients in Nubian goats are shown in table (11).

Dry matter digestibility, OMD, EED, CFD, NFED and TDN were not affected by water restriction, water and feed restriction and feed restriction but CPD was significantly ($P<0.05$) affected by feed restriction, and feed and water restriction but not altered by water restriction. In line with these results Ahmed. (2009) found that feed and water restriction had no effect ($P>0.05$) on the digestibility coefficients of the various nutrients also Silanikove. (1985) and Hadjigorgiou *et al*., (2000) stated that restriction of water intake did not have any significant effect on the digestibility of nutrients.

On the other hand Varga and Prigge (1982), Robinson *et al*. (1985) stated that imposing a reduction of up to 40% in intake of forage diet at near maintenance in sheep, goats and cattle, was found to be associated by no appreciable effect on the digestibility. Also Taha., (2013) Ahmed and Elshafei (2001) and Ahmed (2009) reported the same results. There was a tendency towards decreased digestibility coefficients with water restriction, water and feed restriction, and feed restriction, CPD was decreased significantly with feed restriction, and water and feed restriction compared to control, Taha (2013) and Ahmed (2009) observed similar trend with feed restriction, in the present study CFD tend to increase sligdely compared to control. Contrary to the present study Hassouna (2012) reported that the digestibility coefficient of nutrients as well as TDN increased with water restriction. Also Ahmed

(1989) found that reduction of water intake significantly lowered water loss through both urine and faeces and was associated with slight increases in digestibility coefficients.

During water restriction, slow passage of digesta through the alimentary tract allows more retention time for microbial utilization Sha *et al*., (1987). Taha (2013) said that with the exception of EED the digestibility coefficients of the various nutrients as well as TDN decreased in significantly ($P>0.05$) with feed restriction.

Table (11): Effect of water and feed restriction on the apparent digestibility coefficients of nutrients and total digestible nutrient (TDN) in Nubian goats

Parameter	**Treatments**				**Sig.**
	T_1	**T_2**	**T_3**	**T_4**	
DMD	74.35 ± 1.17^{a}	76.03 ± 1.49^{a}	72.98 ± 3.96^{a}	75.77 ± 4.04^{a}	0.6037
OMD	78.07 ± 0.93^{a}	79.62 ± 1.35^{a}	76.93 ± 3.19^{a}	79.49 ± 3.52^{a}	0.1478
CPD	80.72 ± 0.72^{ab}	83.38 ± 2.12^{a}	78.26 ± 0.86^{b}	83.26 ± 3.03^{a}	0.0347
EED	45.59 ± 20.42^{a}	62.22 ± 3.85^{a}	54.24 ± 16.77^{a}	49.75 ± 11.75^{a}	0.4563
CFD	78.51 ± 1.85^{a}	78.08 ± 1.15^{a}	76.55 ± 4.86^{a}	77.76 ± 3.71^{a}	0.2261
NFED	79.98 ± 0.63^{a}	80.19 ± 1.25^{a}	78.27 ± 4.92^{a}	80.66 ± 3.78^{a}	0.6745
TDN	72.09 ± 1.03^{a}	73.97 ± 1.30^{a}	71.55 ± 3.87^{a}	73.69 ± 3.56^{a}	0.5192

Key:

T_1 ≡ Water *adlib* feed *adlib(control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

* Values are means ±SD of three animals* Values in the same row bearing same superscripts are not significantly different (P>0.05).

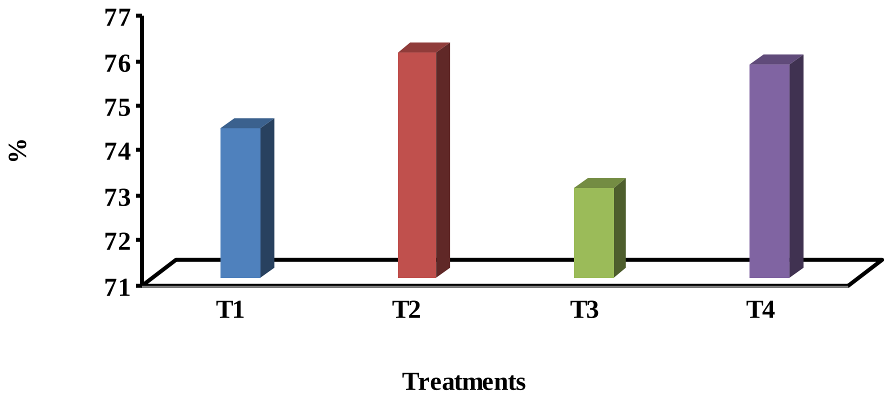

Fig. (28): DMD (Exp. II)

Dry matter digestibility

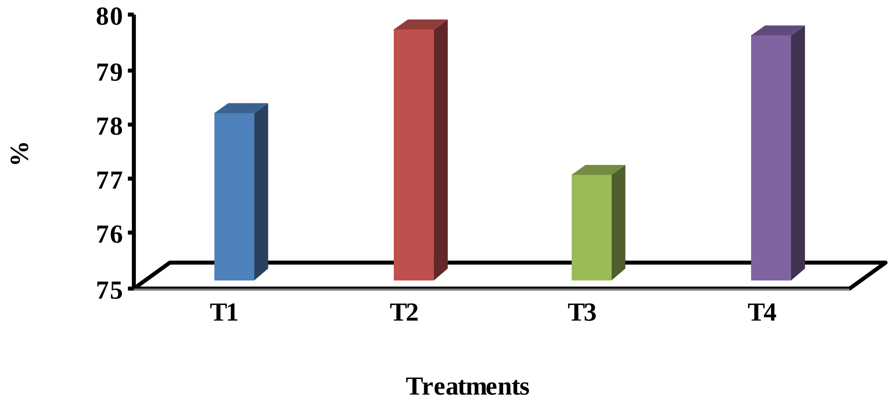

Fig. (29): OMD (Exp. II)

Organic matter digestibility

Key:

T_1 ≡ Water *adlib* feed *adlib (control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

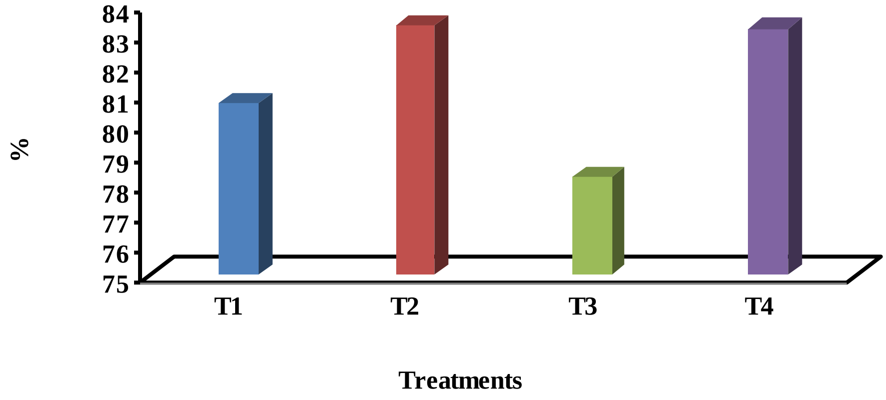

Fig. (30): CPD (Exp. II)

Crude protein digestibility

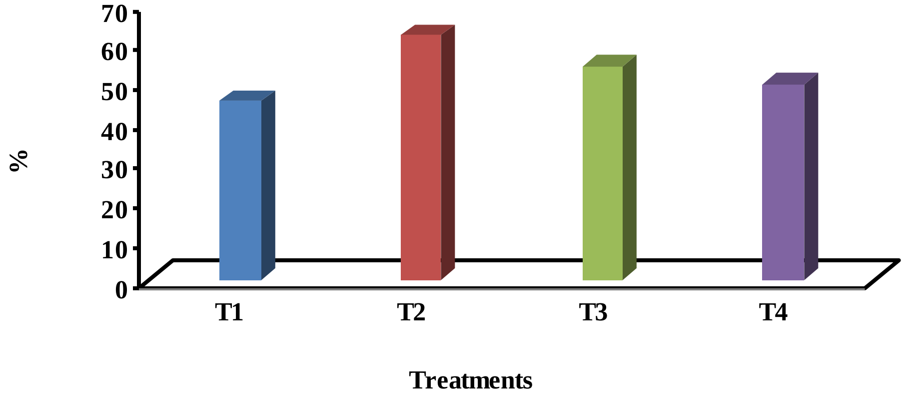

Fig. (31): EED (Exp. II)

Ether extract digestibility

Key:

T_1 ≡ Water *adlib* feed *adlib (control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

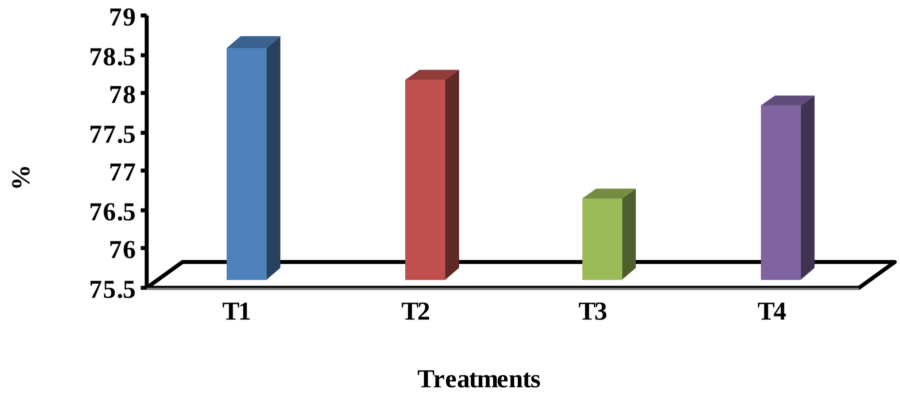

Fig. (32): CFD (Exp. II)

Crude fibre digestibility

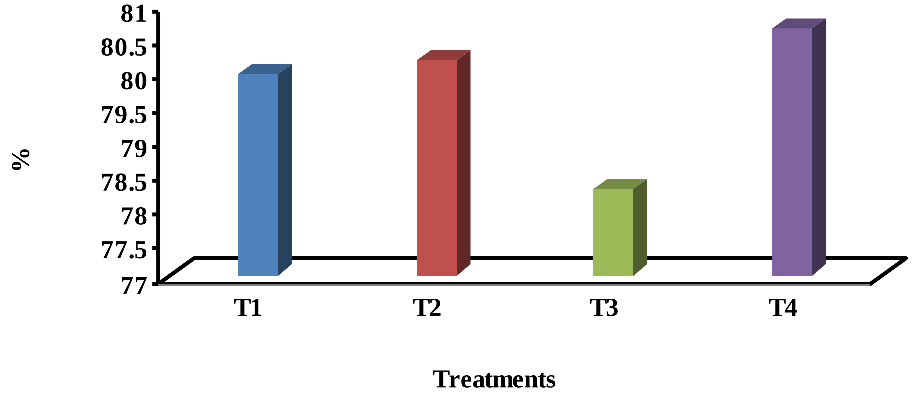

Fig. (33): NFED (Exp. II)

Nitrogen free extract digestibility

Key:

T_1 ≡ Water *adlib* feed *adlib (control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

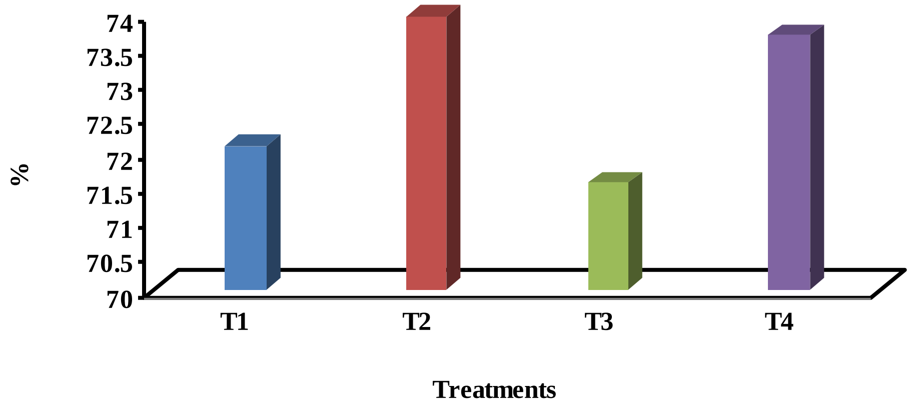

Fig. (34): TDN (Exp. II)

Total digestible nutrient

Key:

T_1 ≡ Water *adlib* feed *adlib (control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

4.2.3 Effect of feed and water restriction on rumen fermentation products and blood urea nitrogen

Effect of water and feed restriction on rumen pH, ruminal ammonia nitrogen (NH_3-N) and blood urea nitrogen (BUN) are shown in table (12).

Rumen pH, NH_3-N and BUN were not affected significantly (P>0.05) by treatments, in line with this result Ahmed (2009) and Ahmed and Abdelatif (1994) who found that pH was not affected (P>0.05) by water restriction and Taha., (2013) and Murphy *et al*. (1994) who found that there were no affect on pH with feed restriction and they observed a tendency to reduction of pH 3hrs after feeding compared to before or 6hrs after feeding the same as the present result. Contrary to this study Ahmed (1989) who said that rumen pH was significantly reduced (P<0.05) with water restriction, and this could be related to reduction in fluidity of rumen contents and increase in the concentration of VFA. It has been reported that the rumen pH is largely a function of VFA Mcmannus, (1962) Ahmed and Abdelatif (1994) also obtained that water restriction signifacntly (P<0.05) decreased pH, also they attributed the reduction in pH to reduction in rumen fluid, reduced Salivary secretion and increase in the concentration of VFA. On the other hand Ahmed (1989) reported that a significant increase (P<0.05) in pH with feed restriction and this result related to low level of VFA production and high ratio of water to DMI also other investigators obtained the same results (Hermesmeyer *et al*., 2002, Zhao *et al*., 1993; Ahmed and Abdelatif, (1994), ruminal NH_3-N was not affected (P>0.05) by both feed and water restriction in line with this result Ahmed (2009) in water restriction and feed restriction and also the result obtained by Taha (2013) in Nubian goats when subjected to 50% feed restriction contrary to these results Hassouna., (2012) who obtained that NH_3-N decreased significantly (P<0.01) with water restriction. The NH_3-N concentration found in this investigation tended to increase 3 hrs after feeding compared to the fasting or 6hrs after feeding, the same result obtained by Hassouna., (2012). Owens and Bergen (1983) reported that concentration ranging from 3.5 to 29 mg/100 ml promote maximal microbial growth.

BUN was not affected ($P>0.05$) significantly except before feeding value that was decreased ($P<0.05$) significantly by treatments compared to 3hrs and 6hrs after feeding. In line with our results, Ahmed (2009) reported that BUN was not affected with water and feed restriction, also Kannan *et al.*, (2007) found that BUN was not affected by water and feed restriction in goats. Hassouna (2012) also found that BUN was not affected by water restriction in both sheep and Nubian goats subjected to 33.33% water restriction, also the same author found that BUN was not affected by feed restricted to 66.66% of adlibitum in both sheep and Nubian goats. On the other hand Cole and Hutcheson (1987) reported that plasma urea-N (PUN) increased ($P<0.05$) as a result of feed and water deprivation.

Blood urea nitrogen increased insignificantly ($P>0.05$) 3hrs after feed compared to fasting or 6hrs after feeding in the four treatments (control, water restriction, water and feed restriction and feed restriction) Taha (2013) and Ahmed (2009) showed similar trend in Nubian goats subjected to 50% feed restriction. Hassouna (2012) also found that BUN increased ($P>0.05$) 3hrs after feeding compared with fasting and 6hrs after feeding when he used sheep and Nubian goats subjected to 50% water restriction the increase in BUN is due to the greater water uptake to kidney and to the decreased blood flow towards the urinary apparatus that causes a reduction of urine and increased of BUN concentration (Casamassim *et al*., 2008). Ahmed (1989) reported that at low level of N intake that accompanied either with water or food restriction, recycling of urea is greatly enhanced, a significant increase in plasma urea level was observed during water restriction, with food restriction, however, the increase in plasma urea level was not significant.

Table No (12): Effect of water and feed restriction and sampling time on rumen pH, ruminal ammona nitrogen (NH_3-N) and blood urea nitrogen (BUN) in Nubian goats

Parameter	**Treatments**				**Sig.**
	T_1	**T_2**	**T_3**	**T_4**	
pH					
Before feeding	7.32 ± 0.09^{a}	7.08 ± 0.12^{a}	7.24 ± 0.47^{a}	7.20 ± 0.45^{a}	0.7384
3 hrs after feeding	6.71 ± 0.13^{a}	6.89 ± 0.15^{a}	6.86 ± 0.21^{a}	6.74 ± 0.09^{a}	0.6813
6 hrs after feeding	7.50 ± 0.29^{a}	7.47 ± 0.74^{a}	7.61 ± 0.57^{a}	7.13 ± 0.52^{a}	0.5039
NH_3–N (mg/100 ml rumen liquid)					
Before feeding	4.99 ± 0.29^{a}	6.21 ± 2.14^{a}	7.47 ± 2.60^{a}	6.07 ± 0.09^{a}	0.4394
3 hrs after feeding	10.73 ± 4.65^{a}	9.29 ± 4.63^{a}	11.15 ± 1.83^{a}	5.17 ± 0.66^{a}	0.1197
6 hrs after feeding	7.33 ± 2.60^{a}	8.07 ± 0.77^{a}	5.23 ± 1.97^{a}	7.65 ± 1.54^{a}	0.3082
BUN (mg/100 ml blood)					
Before feeding	46.70 ± 4.56^{a}	35.30 ± 2.25^{b}	38.57 ± 7.27^{ab}	44.93 ± 6.20^{ab}	0.0996
3 hrs after feeding	56.83 ± 3.89^{a}	36.87 ± 2.47^{a}	44.67 ± 14.55^{a}	49.23 ± 22.76^{a}	0.3976
6 hrs after feeding	44.03 ± 10.86^{a}	38.93 ± 15.41^{a}	46.23 ± 6.47^{a}	49.90 ± 12.44^{a}	0.1383

Key:

T_1 ≡ Water *adlib* feed *adlib(control).*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

* Values are means ±SD of three animals.

Values in the same row bearing same superscripts are not significantly different (P>0.05).

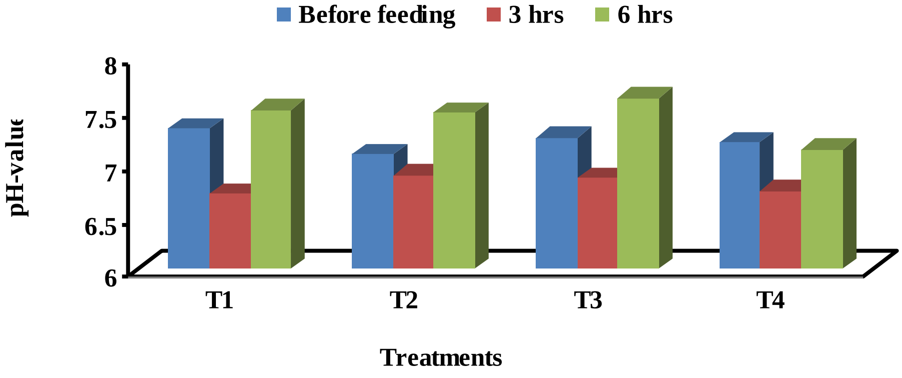

Fig. (35): pH-value (Exp. II)

Ruminal pH value

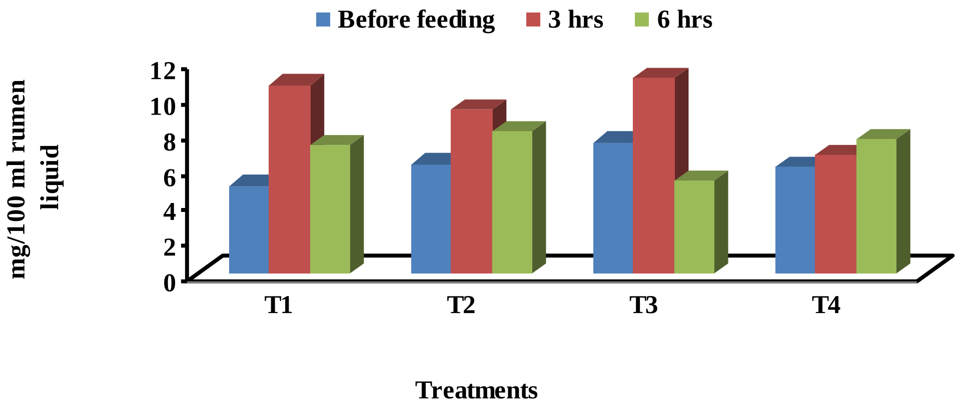

Fig. (36): NH_3-N (Exp. II)

Ruminal ammonia nitrogen

Key:

T_1 ≡ Water *adlib* feed *adlib (control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

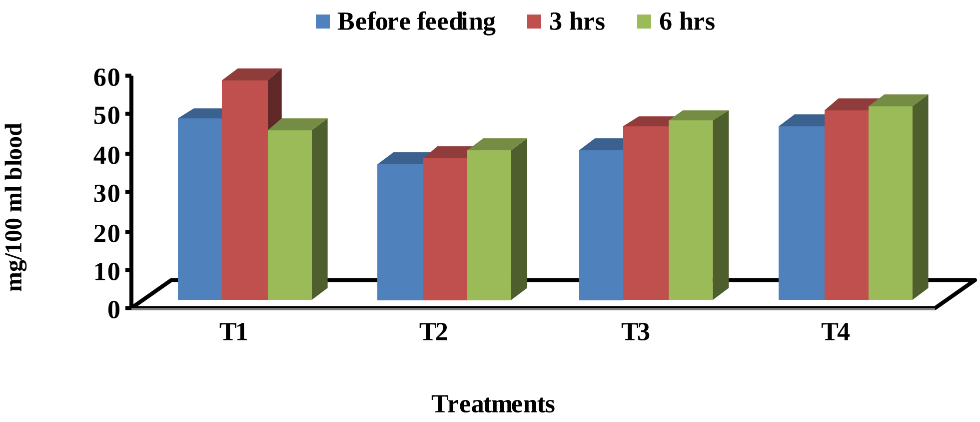

Fig. (37): BUN (Exp. II)

Blood urea nitrogen

Key:

T_1 ≡ Water *adlib* feed *adlib (control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

4.2.4 N-balance as affected by feed and water restriction

The effect of water and feed restriction on nitrogen (N)-balance in Nubian goats are shown in table (13):

Treatments were significantly affected N-intake, faecal-N and nitrogen (N)-balance they were significantly decreased compared to control whereby urinary Nitrogen, NB as % of N-intake and NB as % of digested were not affected by those treatments, Ahmed (1989) reported that total amount of nitrogen (N) ingested decreased significantly with both water and food restriction and this confirms the present study, also found that total amounts of N excreted were greatly reduced with water and food restriction and this also to some extent confirms the present result faecal N decreased ($P<0.05$) significantly by all treatments but urinary N was not altered by treatments Ahmed (1989) also found that feed restriction caused a significant decrease ($P<0.05$) in nitrogen retention where by water restriction, however, did not cause a significant change in the amount of N retained in the other hand, Hassouna (2012) found that all N-balance data decreased with food restricted to 66.66% of adlibitum in Nubian goats. Doreau *et al*. (2003) reported that decreasing intake decreased faecal, urinary and retrained N. Many researchers obtained a negative N-balance with feed restriction in Nubian goats Taha, (2013), Ahmed and Elshafei, (2001) and in sheep (Kamalzadeh, 2004) and these results reflect loss in body tissues and indicate that N was not sufficient to meet the requirements of the animal. (Hassouna, 2012; Ahmed and Elshafei, 2001) mention that N-balance was increased with water restriction. In the present study N-balance in water restriction was lower compared to control but it was higher as compared to other treatments. Yagil (1985) demonstrated that the positive N retention with water restriction in animals on good quality roughage might reflected adaptation to desert conditions, whereby animals would acquire the ability to recycle N through the ruminal wall and Saliva for microbial synthesis. In the present study where feed restricted to 66.66% of adlib and water was restricted to 33.3% of adlibitum N-intake, faecal nitrogen and N-balance were decreased significantly compared to adlibitum water and adlibitum feed (control) whereby urinary N, NB as% of N-intake and NB as% of N digested were not affected (P>0.05).

Table (13): Effect of water and feed restriction on (N)-balance in Nubian goats

Parameter	Treatments				Sig.
	T_1	T_2	T_3	T_4	
N-intake (g/day)	12.70 ± 1.27^{bc}	18.95 ± 0.12^{a}	12.45 ± 1.56^{c}	14.48 ± 0.39^{b}	0.0002
Faecal-N (g/day)	2.49 ± 0.30^{ab}	3.16 ± 0.38^{a}	2.76 ± 0.45^{ab}	2.38 ± 0.38^{b}	0.01376
Urinary-N (g/day)	8.41 ± 3.60^{a}	8.27 ± 0.24^{a}	7.50 ± 2.88^{a}	5.94 ± 0.83^{a}	0.4157
N-balance (g/day)	1.80 ± 3.52^{b}	7.52 ± 0.12^{a}	2.37 ± 2.99^{b}	6.00 ± 0.30^{ab}	0.0429
NB as % of N- intake	14.18 ± 0.19^{a}	39.69 ± 0.58^{a}	18.35 ± 0.21^{a}	41.92 ± 0.76^{a}	0.1788
NB as % of digested- N	17.63 ± 0.32^{a}	47.64 ± 0.54^{a}	23.86 ± 0.62^{a}	50.39 ± 0.79^{a}	0.2394

Key

T_1 ≡ Water *adlib* feed *adlib (control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

* Values are means ±SD of three animals

* Values in the same row bearing same superscripts are not significantly different (P>0.05).

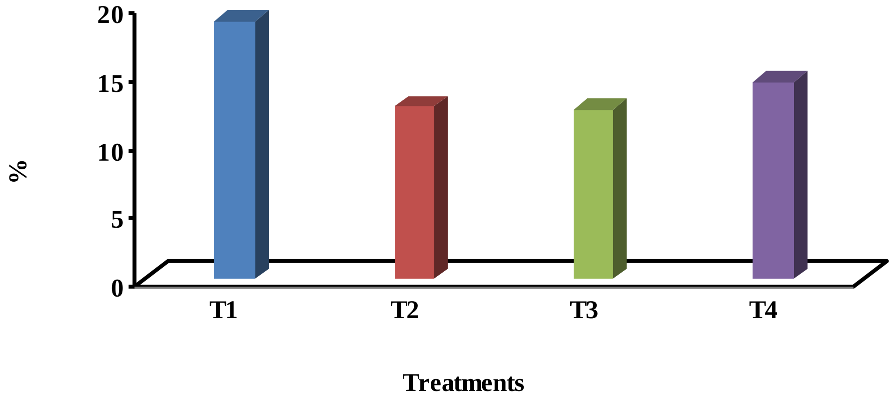

Fig. (38): N-intake (Exp. II)

Nitrogen intake

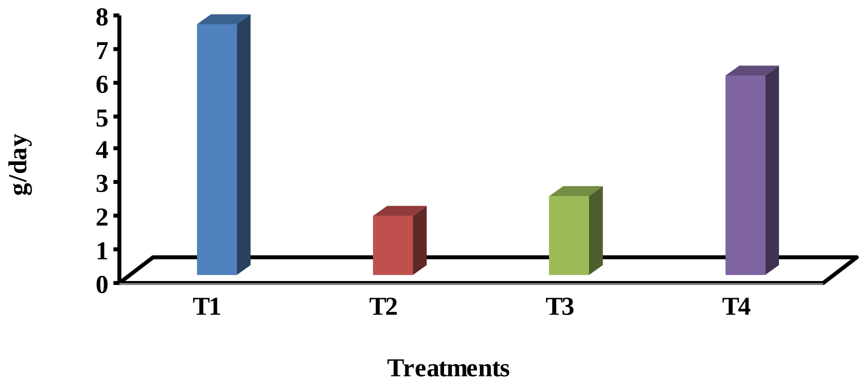

Fig. (39): N-balance (Exp. II)

Nitrogen balance

Key:
T_1 ≡ Water *adlib* feed *adlib (control)*
T_2 ≡ Water *adlib* feed 66.66% from *adlib*
T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*
T_4 ≡ Water 33.3% from *adlib* feed *adlib*

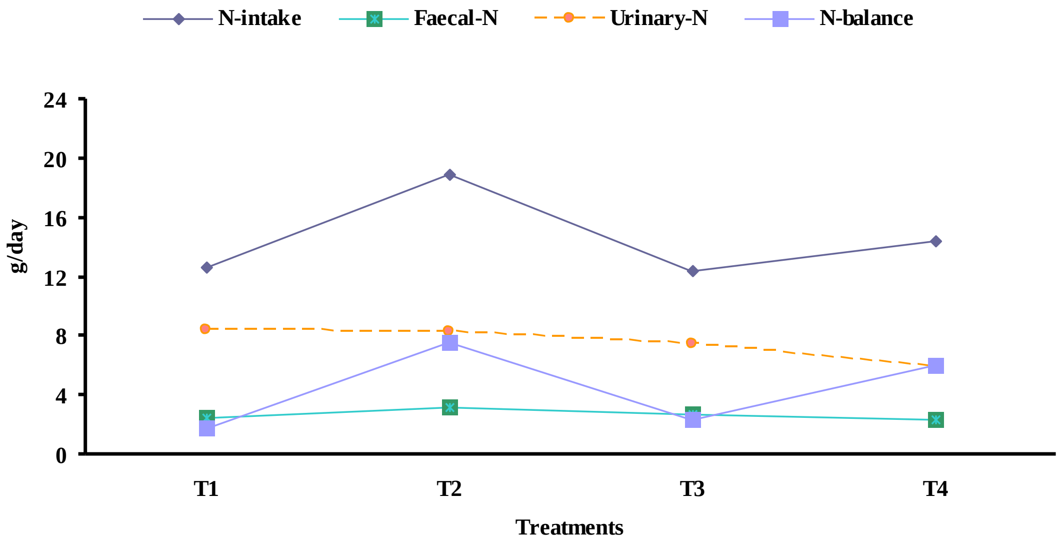

Fig. (40): NB (Exp. II)

Nitrogen balance

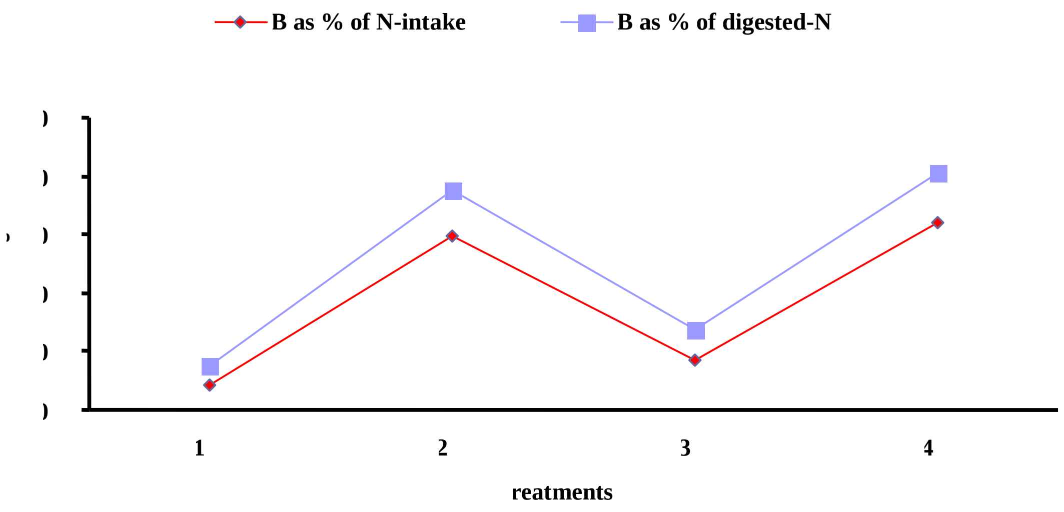

Fig. (41): NB as % of intake and NB as % of digested (Exp. II)

Key :

T_1 ≡ Water *adlib* feed *adlib(control)*

T_2 ≡ Water *adlib* feed 66.66% from *adlib*

T_3 ≡ Water 33.3% from *adlib* feed 66.66% from *adlib*

T_4 ≡ Water 33.3% from *adlib* feed *adlib*

4-3 Experiment No (3):

4.3.1 Effect of feed type and water regime on DMI, WI, WI: DMI ratio faecal DM output, urine volume, RT and RR:

The effect of water restriction and feed type on dry matter intake (DMI), water intake (WI), WI: DMI ratio, faecal DM output, urine volume, rectal temperature (RT) and respiratory rate (RR) in Nubian goats are shown in table (14).

This experiment was conducted at the end of summer when the average minimum temperature was 18ºC and maximum temperature was 33ºC.
The nutritive value of alfalfa (*Medicago Sativa*) was greater than that of Abu70 as reflected by higher CP concentration and lower fibre content (Table 3).

Dry matter intake, WI, WI: DMI ratio, faecal DM output, RT and RR were not significantly affected by treatments imposed with two types of feed, whereas urine volume was highly significant ($P<0.01$) affected by treatments and type of feed, but there were insignificant increase of DMI, WI, with alfalfa hay compared to Abu 70 hay. These results were in line with (Hassouna, 2012) who stated that DMI increased ($P<0.05$) significantly as the result of feeding alfalfa hay compared to Abu70.

The increased in DMI seen with alfalfa hay compared to Abu70 hay may be due to palatability and animal preference to forage that has greater nonstructural carbohydrate contents (Foster *et al*., 2009) in another way (Denck *et al*., 2006) found contradicting results that forage type did not affected DMI in lambs. There were no significant different by treatments in WI but there are slide increased of WI, by alfalfa hay than Abu70 hay this result was in line with the results obtained by (Hassouna, 2012), (Aganga, 1992) and (Denck *et al*., 2006).

Water intake: Dry matter intake ratio was not affected neither by type of feeds nor by treatments contrary to these results other workers (Hassouna, 2012; Ahmed and Elshafei, 2001) who found that WI: DMI ratio was higher with Lucrene hay compared to Abu70 hay. Urine volume was highly significant (P>0.01) affected by treatments, and type of feeds these results may be due to increase in water intake in alfalfa hay compared to Abu 70 hay. Urine volume was highly significant (P<0.01) higher in alfalfa compared to Abu 70.

Rectal temperature and Respiration rate showed no significant (P>0.05) effect by treatment or feed type this may be due to the temperature degree at the experiment time but there are slide increases in RR with alfalfa hay compared to Abu 70 other workers (Hassouna, 2012; Ahmed, 1989; Ahmed and ElKheir, 2004) obtained a significant increase (P>0.05) of RT and RR in Lucerne hay compared to Abu70 hay. Kheir and Ahmed, (2008) reported that RR was higher (P<0.05) due to water restriction with Lucerne hay and Abu70 hay while RT was increased (P<0.05) only with Lucrene hay.

Table (14): Effect of water regime and feed type on dry matter intake (DMI), water intake (WI), WI: DMI ratio, faecal DM output, urine volume, rectal temperature (RT) and respiratory rate (RR) in Nubian goats:

Parameter	Time (hrs).				Sig.
	24		48		
	Ration				
	Abu 70	Alfalfa	Abu 70	Alfalfa	
DMI (kg/day)	0.44±0.04[a]	0.61±0.01[a]	0.39±0.05[a]	0.54±0.04[a]	0.8137
WI:DMI ratio kg/day	1.22±0.04[a]	1.88±0.10[a]	1.15±0.06[a]	1.55±0.22[a]	0.5899
Water intake: DMI	2.80±0.35[a]	3.08±0.22[a]	2.95±0.35[a]	2.85±0.20[a]	0.6579
Faecal DM output (kg/day)	0.22±0.05[a]	0.26±0.03[a]	0.15±0.02[a]	0.18±0.03[a]	0.7932
Urine volume (cm^3)	33.27±42.00[d]	246.70±72.15[b]	40.27±11.09[c]	268.30±30.14[a]	0.0074
RT (°C)	38.38±0.42[a]	38.45±0.32[a]	38.09±0.10[a]	38.21±0.23[a]	0.5947
RR (breath/min$^-$)	29.00±2.64[a]	29.00±1.73[a]	29.00±4.85[a]	30.00±1.73[a]	0.6703

* Values are means ±SD of three animals

* Values in the same row bearing same superscripts are not significantly different (P>0.05).

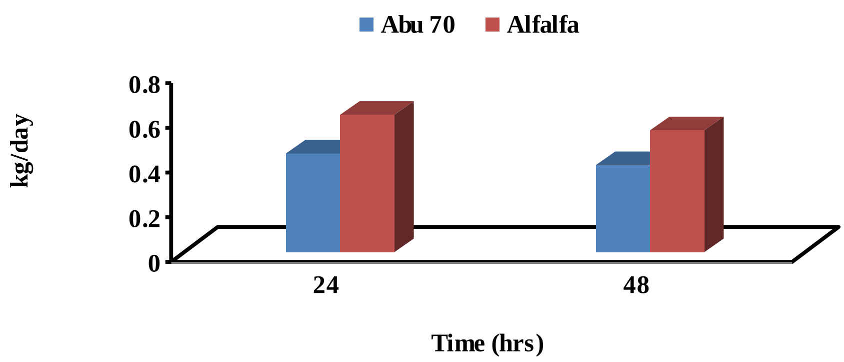

Fig. (42): DMI (Exp. III)

Dry matter intake

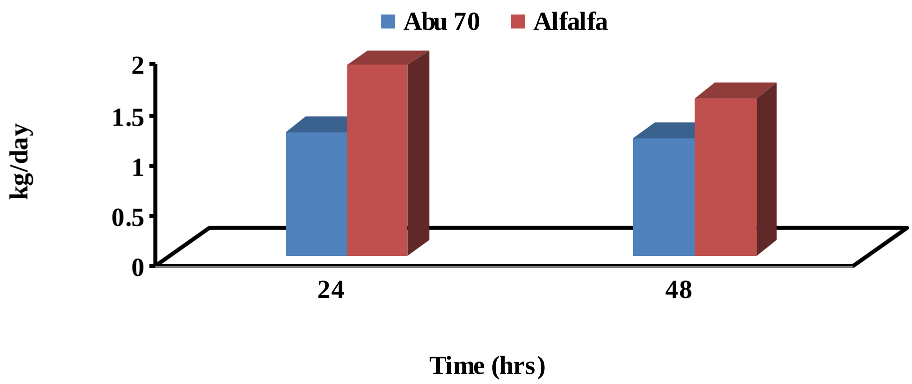

Fig. (43): WI (Exp. III)

Water intake

Key:

24≡water every 24 hours

48≡water every 48 hours

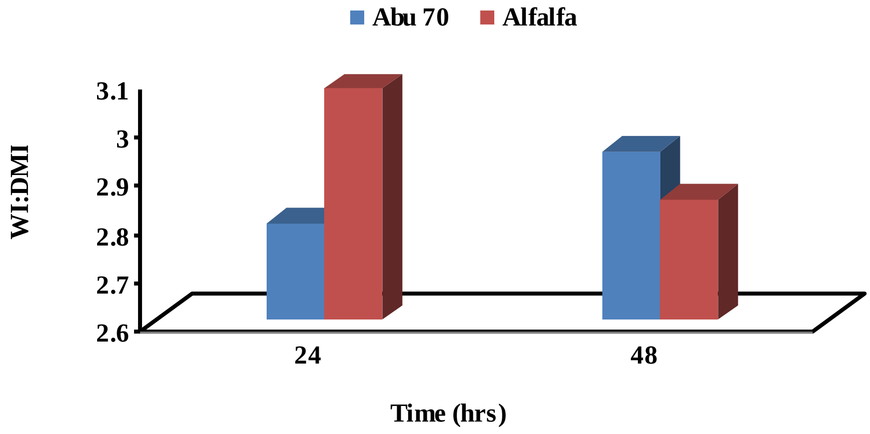

Fig. (44): WI: DMI ratio (Exp. III)

Water intake **:** Dry matter intake ratio

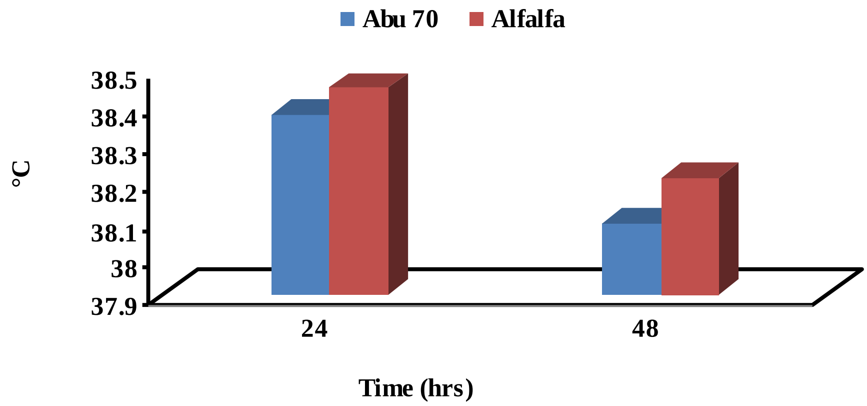

Fig. (45): RT (Exp. III)

Rectal temperature

Key:

24≡water every 24 hours

48≡water every 48 hours

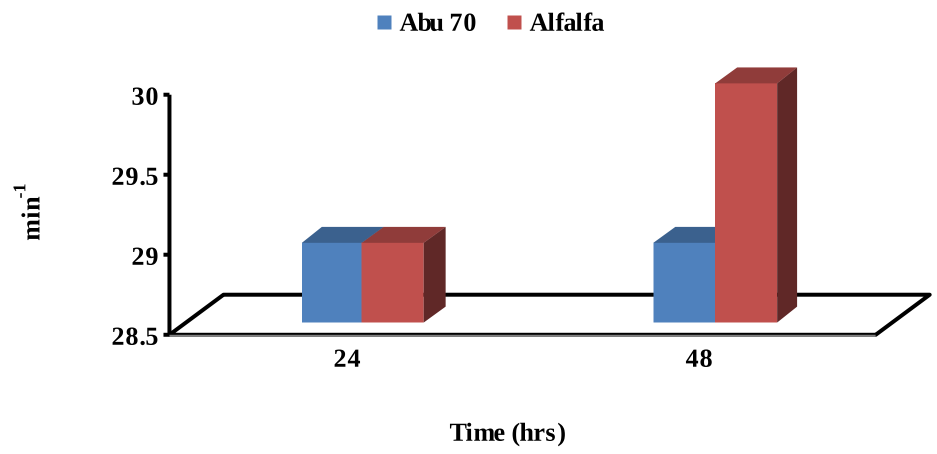

Fig. (46): RR (Exp. III)

Respiration rate

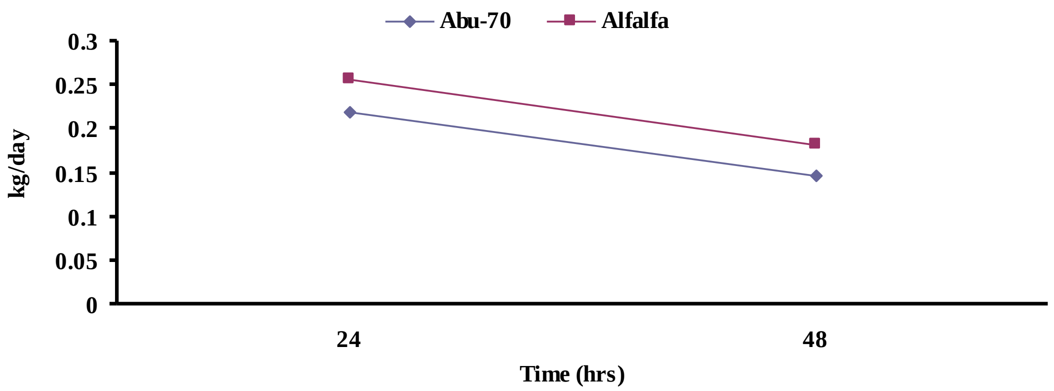

Fig. (47): Faecal DM output (Exp. III)

Faecal dry matter out put

Key:

24≡water every 24 hours

48≡water every 48 hours

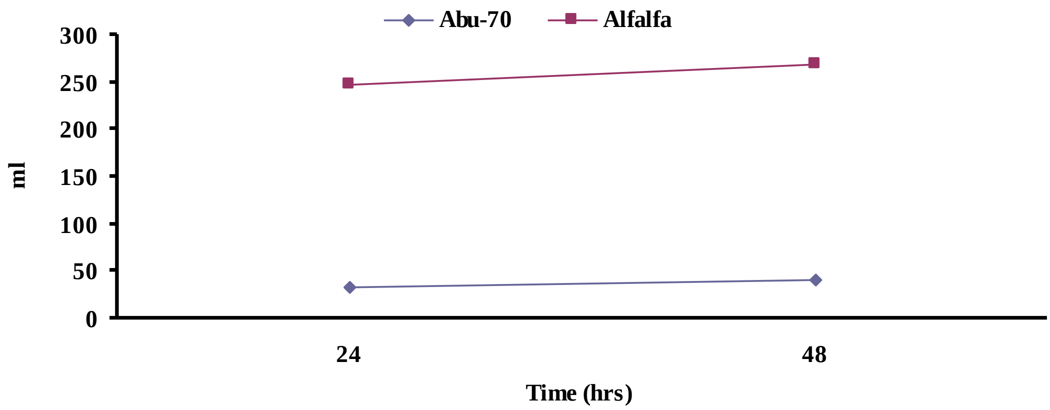

Fig. (48): Urine volume (Exp. III)

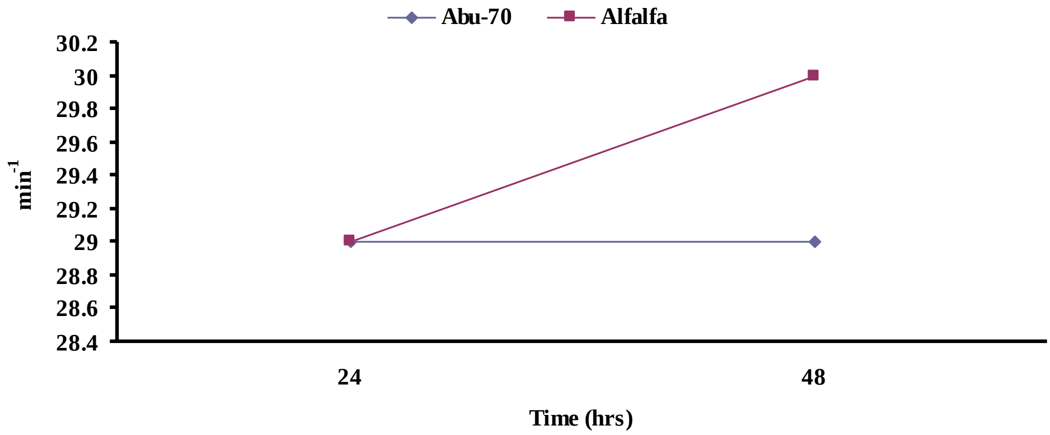

Fig. (49): RR (Exp. III)

Respiration rate

Key:

24≡water every 24 hours

48≡water every 48 hours

4.3.2 Effect of feed type and water regime on the digestibility coefficients of nutrients

The effect of water regime and feed type on the apparent digestibility coefficient of nutrients in Nubian goats is shown in table (15): CPD, EED, CFD, NFED and TDN are significantly (P<0.05) affected by both water restriction and feed type. These results were in line with the results obtained by (Ahmed and Elshafi, 2001) who said that water restriction was found to improve digestibility as the a retention time of the digesta increased giving more time for microbial degradation and synthesis and most of nutrient digestibility was increased with Lucerne hay. CP digestibility was significantly increased (P<0.05) by water restriction on alfalfa hay compared to Abu70 hay this was in line with Ahmed and Elshafei (2001), who found that CPD was better with Lucerne than sorghum also Osman and Fadalla (1974) found the same result. Hassouna (2012) reported that CP digestibility of alfalfa hay and sorghum straw was almost similar Ahmed and Elshafie (2001) said that with grass hay the effect of water restriction was not significant except for CPD which was significantly reduced; this might be due to the low CP concentration in the diet accompanied by low water supply that could support microbial degradation, CFD was significantly (P<0.05) affected by water restriction and feed type, water restriction improved CFD, this may be due to the absence of adequate water, the passage of ingesta through the digestive tract will slow down allowing more time for micro-organisms to digest available feed, CFD was significantly higher (P<0.05) with Abu70 hay than alfalfa hay this result was on line with (Hassouna, 2012), also Mertens and Loften (1980) reported that alfalfa had a lower CFD compared to sorghum hay, this could be related to the low level of the nutrient in the diet.

EED and NFED in this study was significantly affected ($P<0.05$) by water restriction and feed type. EED was higher in water restriction in the two types of feeds and it was higher in Abu70 hay than alfalfa hay. NFED was higher in Abu70 hay when water was given every 24 hours but it was lesser when water was after every 48 hours, this result was in line with that obtained by Ahmed and Elshafie (2001) who reported that NFED was significantly ($P<0.05$) reduced when animals were kept on Lucerne hay contrary to our results Osman and Fadlalla (1974) who obtained that NFED for four types of feeds (berseem, lubia, maize and concentrate) were slightly improved by water restriction.

Table (15): Effect of water regime and feed type on the apparent digestibility coefficients of nutrient in Nubian goats:

Parameter	Time (hrs).				Sig.
	24		48		
	Ration				
	Abu 70	Alfalfa	Abu 70	Alfalfa	
DMD	65.90 ± 5.70^{b}	64.63 ± 9.18^{b}	75.22 ± 5.51^{a}	76.63 ± 4.80^{a}	0.0246
OMD	65.20 ± 5.94^{c}	64.98 ± 10.66^{c}	73.40 ± 3.37^{b}	78.10 ± 4.50^{a}	0.0385
CPD	56.57 ± 9.77^{c}	82.96 ± 4.08^{a}	65.26 ± 6.25^{b}	83.17 ± 6.62^{a}	0.0219
EED	40.00 ± 20.00^{c}	25.00 ± 12.50^{d}	61.67 ± 12.58^{a}	54.16 ± 10.16^{b}	0.0183
CFD	66.88 ± 5.30^{c}	63.32 ± 8.53^{d}	84.00 ± 10.44^{a}	75.99 ± 11.17^{b}	0.0264
NFED	66.31 ± 6.68^{c}	62.12 ± 11.00^{d}	73.80 ± 2.33^{b}	75.74 ± 6.33^{a}	0.0188
TDN	57.15 ± 5.38^{c}	55.32 ± 7.18^{d}	66.98 ± 0.90^{a}	64.35 ± 3.86^{b}	0.0217

* Values are means ±SD of three animals

* Values in the same row bearing same superscripts are not significantly different (P>0.05).

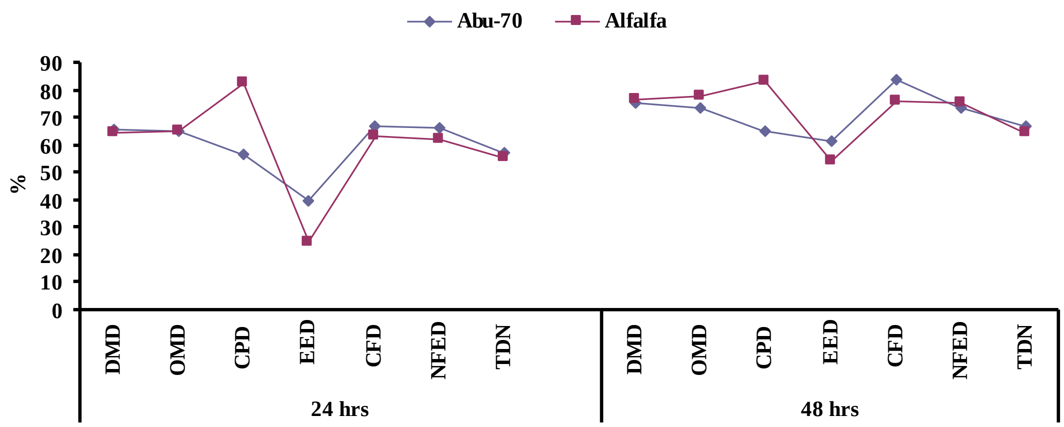

Fig.: (50) Exp.(III)

Nutrients digestibility

Key:

24≡water every 24 hours

48≡water every 48 hours

4.3.3 Effect of feed type and water regime on rumen fermentation products and blood urea nitrogen

The effect of water regime and feed type on rumen pH, ruminal ammonia nitrogen (NH_3-N) and blood urea nitrogen BUN in Nubian goats are shown on table (16).

Rumen pH before feeding was significantly affected ($P<0.05$) by feed type but not affected by water regime, on the other hand PH 3hrs and 6hrs after feeding were not affected ($P>0.05$) by water regime nor by feed type. (Hassouna, 2012) reported that pH was not ($P<0.05$) significantly affected by feed type in desert sheep and Nubian goats when used Lucrene hay and sorghum hay, also (Li *et al*., 2008) and (Foster *et al*., 2009) who demonstrated that dietary type had no effect on rumen pH. Sampling time induced a significant ($P<0.01$) effect on pH before feeding compared to 3hrs and 6hrs after feeding also (Hassouna, 2012) and (Rumsey *et al*., 1969) reported that sampling time affected ($P<0.05$) the rumen pH.

Rumen NH_3-N concentrations were significantly ($P<0.05$) affected by the type of feed it was higher ($P<0.05$) with Lucerne hay compared to Abu70 hay. Treatments also affected ($P<0.05$) rumen NH_3-N when used Lucrene hay but treatment not affected ($P>0.05$) NH_3-N when using Abu70 hay. Hassouna (2012) stated that Rumen NH_3-N concentration was affected significantly ($P<0.05$) by feed type in sheep and Nubian goats when used Lucrene hay and sorghum hay, also Li *et al*. (2008) attributed the difference in ruminal NH_3-N concentration among diets to difference in dietary CP content. In this study, alfalfa hay showed higher NH_3-N concentration than sorghum hay. Foster *et al*., (2009) reported that Legume hay supplementation increased N intake because of greater

Crude protein concentrations of the Legumes. Legume supplementation increased ruminal NH_3-N concentrations because it increased N intake relative to the poor quality warm season grasses, and most of the protein in legumes in the form of soluble protein or rumen degradable protein (Broderick, 1995). Sampling time had no effect ($P>0.05$) on NH_3-N this result is in line with (Lutfi and Ahmed, 2010), but in contrast with the finding of (Hassouna, 2012) who reported that the rumen NH_3-N concentration increased significantly ($P<0.01$) 3hrs after feeding compared to before feeding or 6hrs after feeding when using two types of feed in desert sheep and Nubian goats, rumen NH_3-N was affected ($P<0.05$) by watering regime when used alfalfa hay but was not affected by treatment when using Abu 70, rumen NH_3-N tends to decrease by water restriction 3hrs after feeding.

Blood urea nitrogen was significantly affected ($P<0.01$) by feed type. Alfalfa hay had a higher BUN compared to Abu70 hay. This result was in line with the finding obtained by (Hassouna, 2012) who said that alfalfa hay had a higher BUN compared to sorghum straw (57.43 Vs 17.64 mg/100 ml blood) also (Kheir and Ahmed, 2008) found that plasma urea nitrogen (PUN) increased significantly with feeding Lucerne hay compared to grass hay also (Cole *et al*., 1986) reported that the only blood variable significantly affected by diet was PUN (Zanton and Heinrichs, 2009) found that urea –N excretion increases linearly with N intake.

In this study, alfalfa hay had higher N intake than Abu70 hay. The increase in PUN concentrations could be an indication of an increase in tissue protein catabolism and (or) a reduction in tissue protein synthesis.

Blood urea nitrogen was affected significantly (P<0.01) by water regime in the two types of feed it was decreased before and 6hrs after feeding and increased 3hrs after feeding with 48hrs water regime in sorghum hay on the other hand it was not affected before feeding and increased 3hrs and 6hrs after feeding with 48hrs watering regime compared to 24hrs watering regime in Lucerne hay this was agreeing with Ahmed and Abdelatif, (1994) and Burgos *et al*. (2001) who obtained that BUN increased with water restriction when used Lucerne hay. The increase in BUN is due to the greater water uptake to kidney and to the decreased blood flow towards the urinary apparatus that causes a reduction of urine and the increase of BUN concentration (Casamassima *et al*., 2008)

Table (16): Effect of water regime and feed type on rumen pH, ruminal ammonia nitrogen (NH_3-N) and blood urea nitrogen (BUN) in Nubian goats:

Parameter	Time (hrs).				Sig.
	24		48		
	Ration				
	Abu 70	Alfalfa	Abu 70	Alfalfa	
pH-value					
Before feeding	6.72±0.08^b	7.43±0.10^a	6.90±0.30^b	7.28±0.20^a	0.0387
3 hrs after feeding	5.69±0.10^c	5.90±0.17^c	6.95±0.06^b	6.32±0.46^b	
6 hrs after feeding	5.70±0.00^c	5.99±0.00^c	6.19±0.18^b	6.04±0.22^b	
NH_3 N (mg/100 ml rumen fluid)					
Before feeding	5.41±0.86^c	5.13±1.13^c	5.15±0.30^c	7.68±0.81^a	0.0436
3 hrs after feeding	4.74±1.03^d	7.11±1.57^a	4.32±0.31^d	6.93±0.70^b	
6 hrs after feeding	4.20±0.28^d	6.30±1.82^b	4.53±0.49^d	5.88±0.78^c	
BUN (mg/100 ml blood)					
Before feeding	26.61±10.66^f	47.94±11.59^b	22.65±3.90^g	47.63±27.41^b	0.0105
3 hrs after feeding	18.78±1.12^e	43.76±9.97^c	23.47±4.47^g	57.51±7.74^a	
6 hrs after feeding	30.14±24.62^e	38.39±7.32^d	20.08±7.59^d	41.15±16.39^c	

* Values are means ±SD of three animals

* Values in the same row bearing same superscripts are not significantly different (P>0.05).

4.3.4 Nitrogen balance as affected by feed type and water regime

The effects of water regime and type of feeds on N-balance in Nubian goats are shown in table (17).

Nitrogen intake, urinary-N, and Nitrogen balance were affected significantly (P<0.05) by feed type, but not affected by treatments they were higher with alfalfa hay and lower with Abu 70 hay, also there is slide insignificant (P>0.05) increase in faecal-N with alfalfa hay compared to Abu70 hay in line with these results Elshafie (1999) obtained a significant (P<0.05) increased in N-retention in the animals fed Lucerne hay compared to grass hay in both water and feed restricted groups. Osman and Fadlalla (1974) reported that when Hummara was fed to animals, nitrogen retention was greater, though not significantly so, in the case of the adlibitum water than in the restricted water, they also obtained that retention was negative in both treatments, they said that a lower nitrogen retention from hummra when the rams water intake was restricted could be attributed to the lower feed intake of the rams on restricted water intake and to other factors related to the nature of the feed itself, Hummra is very fibrous and of low nitrogen content. Also Brosh (1987) reported that when goats were fed on Lucerne hay, the nitrogen intake of the goats as well as their urea entry rates and urea recycling rates were all higher when water was offered daily than when the goats were given water infrequently, infrequent drinking however, had no effect on the rate of urea recycling when the goats were fed low quality roughages. Hassouna (2012) found that feed type affected significantly (P<0.01) N intake, faecal N and urinary N, that N intake was higher with alfalfa hay compared to sorghum straw. Also Ahmed and Elshafei (2001) reported higher N intake with Lucrene than with sorghum hay. Bergner *et al*., (1989) observed negative N balance when water was restricted to 33.3% of free intake and feed (Lurene) was given at maintenance. In the present study N balance was positive in the two types of water regimes (every 24hrs or every 48hrs) in the two types of feed indicating that N was sufficient to meet the requirements of the animal. Also the higher N excretion in faeces and urine with alfalfa hay would reflect the higher CP content and higher N intake, this confirms the finding of Hassouna (2012) and Foster *et al*., (2009) who found that N intake, faecal N, and urinary N increased as CP increased in animals feed on different forage legume hays N-balance was higher with alfalfa hay compared to Abu 70 hay, this is in accord with the result obtained by Ahmed and Elshafei (2001).

Tag ElDin *et al*., (1989) recorded that animals fed on sorghum straw alone usually result in a negative N-balance, in this study positive N balance was observed with animals fed Abu70 hay. This is in line with the finding obtained by Silanikove *et al*., (1980) Choshniak and Arnom (1985) and Hassouna (2012) who noted that the higher efficiency of Desert goats in terms of economizing its metabolism by recycled urea was not demonstrated on high protein rations.

Table (17): Effect of water regime and type of feed on N-balance in Nubian goats

Parameter	Time (hrs)				Sig.
	24		48		
	Abu 70	Alfalfa	Abu 70	Alfalfa	
N-intake (g/day)	1.09±0.00[b]	3.22±0.00[a]	1.09±00[b]	3.22±0.00[a]	0.0439[*]
Faecal-N (g/day)	1.43±0.27[a]	1.57±0.08[a]	1.48±0.16[a]	1.74±0.11[a]	0.6956[NS]
Urinary-N (g/day)	1.12±0.25[b]	2.87±0.34[a]	1.26±0.40[b]	2.67±0.32[a]	0.0457[*]
N-balance (g/day)	2.28±0.44[c]	9.04±0.62[a]	2.08±0.69[d]	7.56±1.47[b]	0.1954[**]
NB as % of N-intake	49.39±8.70[a]	48.02±4.39[b]	49.98±11.95[a]	44.82±5.65[b]	0.0308[*]
NB as % of digested N	89.12±12.41[a]	56.83±1.06[c]	78.43±15.21[b]	51.21±5.62[d]	0.0019[**]

Values are mean±SD.

* is considered significant ($P \leq 0.05$)

** is considered highly significant at ($P \leq 0.01$)

NS = not significant

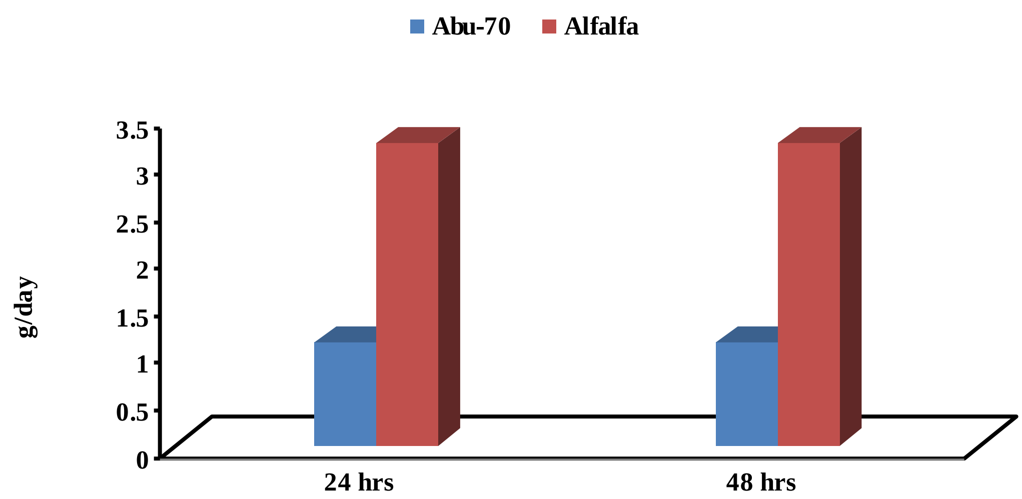

Fig. (51): N-intake (Exp. III)

Nitrogen intake

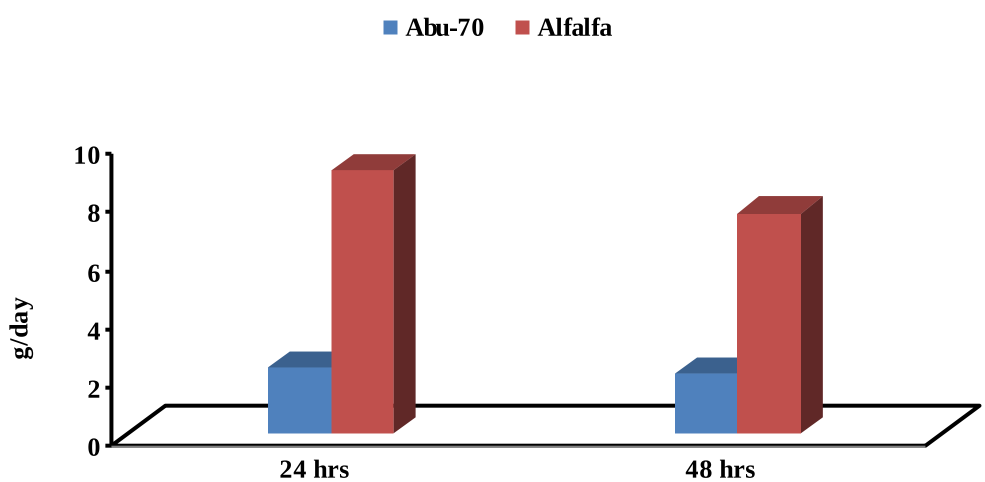

Fig. (52): N-balance (Exp. III)

Nitrogen balance

Key:

24≡water every 24 hours

48≡water every 48 hours

4-4 Experiment No (4):

4.4.1 Effect of water or feed restriction on DMI, WI, WI: DMI ratio, faecal DM output, urine volume, RT and RR:

The effect of water or food restriction on DMI, WI, WI: DMI ratio faecal DM output, urine volume, RT and RR are shown in table (18).

Dry matter intake was affected ($P<0.05$) significantly by feed restriction but there was no effect on WI, on the other hand, water restriction significantly affected ($P<0.05$) WI, but no effect on DMI, faecal output and RT were not affected ($P>0.05$) significantly by water restriction nor by feed restriction, WI: DMI ratio was significantly affected by treatments that it decreased by water restriction and increased by feed restriction. Urine volume was highly ($P<0.01$) significantly affected by treatments that it decreased with water restriction and increased with feed restriction. RR was decreased significantly ($P<0.05$) with both feed and water restriction in line with these results that obtained by (Hassouna, 2012) who said that DMI was not affected by water restriction when used desert sheep and Nubian goats and also obtained on other experiment that DMI was highly affected ($P<0.01$) by feed restriction. Ahmed and Elshafei, (2001); and Casamassima *et al*., (2008) observed that imposing restriction ranging between 40% and 80% in water intake in sheep and goats was found to have no effect on DMI. If ruminants failed to decrease food intake during dehydration, it might even compromise the osmotic buffer function of the rumen, because it might increase rumen fluid osmolality so much to prevent the use of rumen water to alleviate the systemic hypertoncity of dehydration (Burgos *et al*., 2001) water restriction to 33.3% of adlibitum resulted in a significant reduction in water intake this result was on line with Hadjigeorgiou *et al*. (2000). Ahmed and Elshafei (2001) and Ahmed (2009) who obtained insignificant affect of water intake by water restriction, water intake was not affected by feed restriction. Ahmed, (2009) obtained the same results but Ahmed and Abdelatif, (1994) found that feed restriction resulted in significantly decrease in water intake also Ahmed and Elshafei (2001) said that water intake was found not to be affected by feed restriction in desert goats when fed Lucerne hay. WI: DMI ratio was significantly ($P<0.05$) affected by treatments that it was decreased with water restriction and increased with feed restriction this result was in line with Hassouna, (2012) who obtained that WI:DMI was significantly ($P<0.01$) higher when animals (Sheep and Nubian goats) had adlibitum access to water, also Ajibola (2006) obtained that WI: DMI ratio decreased significantly when goats were subjected to water restriction (30%, 50% and 100% of the adlibitum WI) similar results were reported by Alamer (2009) who found a significant decreased in WI:DMI ratio with 50% and 25% water restriction in goats also Ahmed (1989) reported that reduction of water intake significantly lowered the ratio of WI: DMI. On the other hand feed restriction increased the ratio of WI: DMI, same results obtained by (Ahmed, 2009) who reported that WI: DMI ratio increased with feed restriction also Hassouna (2012) reported that the level of feed consumption affects the relationship between WI and DMI that WI: DMI ratio was higher ($P<0.01$) significantly increased in feed restricted animals (desert sheep and Nubian goats) than those fed adlibitum. Ahmed and Elshafie (2001) recorded that the ratio of WI: DMI increased in desert goats fed on high and low quality forages subjected to feed restriction (40% of the adlibitum level), Taha (2013) and Lutfi and Ahmed (2010) observed a significantly increased WI: DMI ratio as a result of 50% feed restriction in Nubian goats fed on alfalfa hay, faecal dry matter output was not affected (P>0.05) by water restriction nor by feed restriction. Ahmed and Abdelatif (1994) obtained insignificant (P>0.05) reduction in faecal dry matter output with both water and feed restriction, Ahmed (2009) reported that faecal DM output was decreased (P<0.05) when feed restricted to 50% of adlibitum urine volume was highly (P<0.01) significantly affected by treatment. It was decreased by water restriction (this would illustrate a tendency to conserve body water during periods of water scarcity) and increased by feed restriction Ahmed (2009) obtained that urine volume was reduced numerically by water restriction, in line with the present study. Schmidt-Nielsen (1964) stated that water restriction decreased total urine volume and enhanced urea recycling to the fore stomach. In line with this study (Hassouna, 2012) who obtained a significant (P<0.05) difference between treatment groups in the amount of water lost through urine, Teixira *et al*., (2006) found that urine volume in goats subjected to 30% feed restriction was higher than 100% restriction treatment groups, they observed a linear relationship between water intake and water loss through urine which is in agreement with the present study. Contrary to this result (Ahmed, 2009) reported that urine volume decreased (P<0.05) with feed restriction. RT was not affected by water restriction nor by feed restriction in line with this result that obtained by (Ahmed, 2009) who reported that feed restriction did not affect RT, also (Taha, 2013) reported that feed restriction did not affect RT in Nubian goats. The same result obtained by Lutfi and Ahmed (2010) and Hassouna (2012) reported that water restriction causes an increase in RT, the same finding obtained by Sevi *et al*. (2009). Ahmed and Abdelatif

(1994), Ahmed and Elkheir (2004) and Hassouna (2012) reported that RT was reduced by feed restriction. RR was significantly affected ($P<0.05$) by treatments that it was decreased with both water and feed restriction, in line with this finding Ahmed (2009) obtained that RR decreased with both feed and water restriction also, the same result obtained by Ahmed (1989) who said that RR decreased significantly with both water and feed restriction during the morning and the afternoon, this would indicate a general decline in metabolism also this would indicate that RR were regulated to maintain body core temperature. Taha (2013) observed that RR decreased ($P>0.05$) with feed restriction, the same result obtained by Lutfi and Ahmed (2010) Murray *et al*. (1990) observed that animals with the highest DMI had the highest RR, also Hassouna (2012) and Sevi *et al*. (2009) noted that water restriction caused an increase in respiratory rate.

Table (18): The effect of water or food restriction on DMI, WI, WI: DMI ratio, faecal DM output, urine volume, RT and RR in Nubian goats

	T_1	T_2	T_3	Sig.
DMI (kglday)	0.93±0.07[a]	0.89±0.09[a]	0.31±0.00[b]	0.0457*
Water intake (cm^3/day)	2.64±0.81[a]	0.95±0.20[b]	2.18±.20[a]	0.492*
WI: DM ratio intake	2.81±0.72[b]	1.10±0.28[c]	7.17±0.70[a]	0.0263*
Faeces DM output (kglday)	0.29±0.10[a]	0.70±0.90[a]	0.16±0.08[a]	0.1518[NS]
Urine volume (cm^3)	471.85±409.50[b]	165.97±83.13[c]	587.21±60.15[a]	0.0004**
RT (^{O}C)	38.75±0.94[a]	38.16±0.34[a]	37.35±0.66[a]	0.1682[NS]
RR (breathe/min.)	36.67±3.21[a]	34.67±3.21[b]	33.33±3.51[b]	0.0459*

Values are mean ±SD.

*is considered significant ($P \leq 0.05$)

** is considered highly significant at ($P \leq 0.01$)

NS = not significant

T_1: water adlib. Feed adlib. (Control).

T_2: Water restricted to 33.33% from adlib feed adlib.

T_3: Water adlib. Feed restricted to 33.33% from adlib.

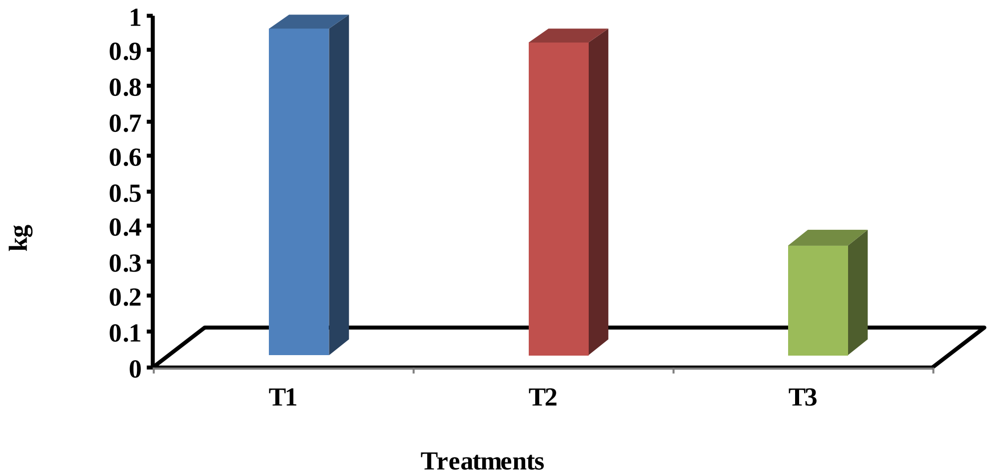

Fig. (53): DMI (Exp. IV)

Dry matter intake

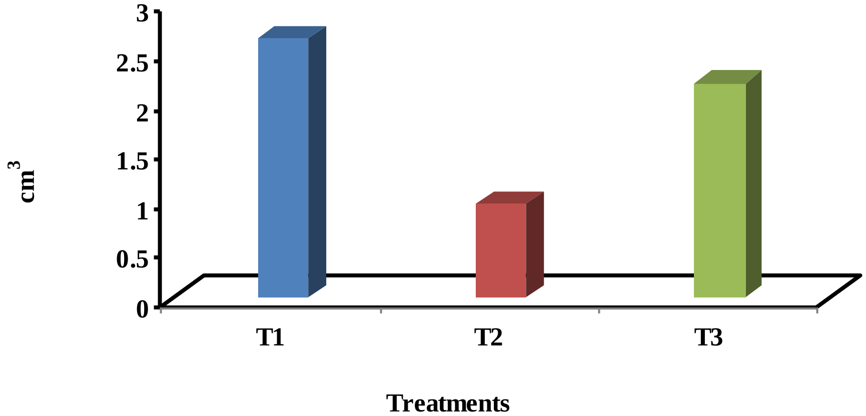

Fig. (54): WI (Exp. IV)

Water intake

Key

T_1 ≡ Feed adlib. and water adlib. (control)
T_2 ≡ water restricted to 33.3% from adlib. and feed adlib.
T_3 ≡ water adlib. and feed restricted to 33.3% from adlib.

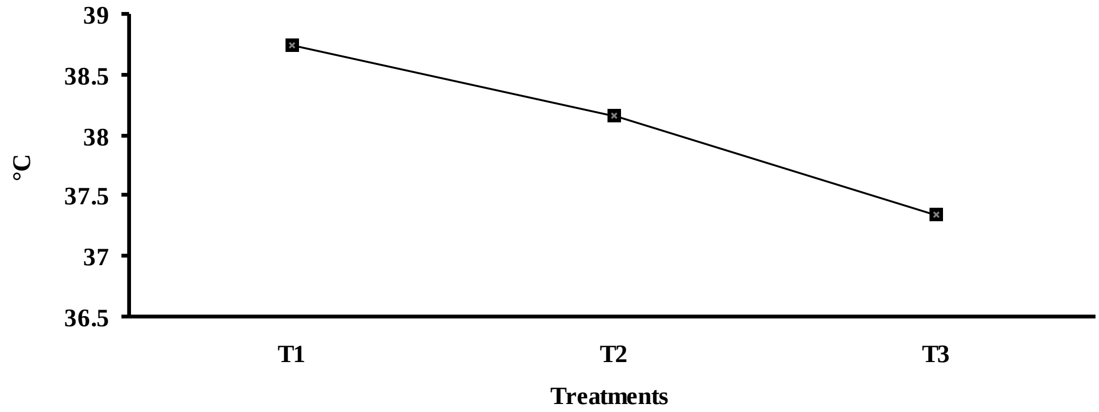

Fig. (55): RT (Exp. IV)

Rectal temperature

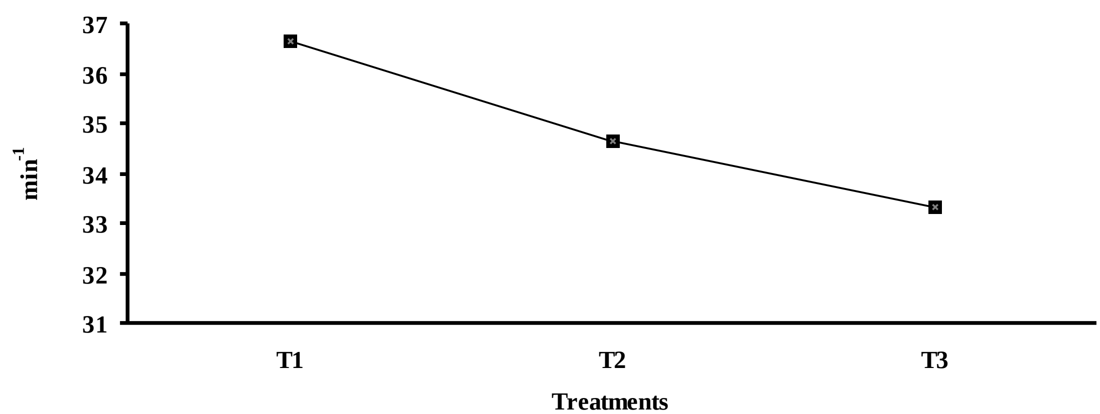

Fig. (56): RR (Exp.IV)

Respiration rate

Key

T_1 ≡ Feed adlib. and water adlib. (control)
T_2 ≡ water restricted to 33.3% from adlib. and feed adlib.
T_3 ≡ water adlib. and feed restricted to 33.3% from adlib.

4.4.2 Effect of water or feed restriction on the digestibility coefficients of nutrients

Apparent digestibility coefficients of nutrients and total digestible nutrients (TDN) as affected by water or feed restriction on Nubian goats are shown in table (19).

Apparent digestibility coefficients of nutrients and TDN were affected significantly by treatments that they increased by water restriction and decreased by food restriction on line with this result (Ahmed, 1989) and Hassouna (2012) who reported that the digestibility coefficients of nutrients as well as TDN increased with water restriction, Osman and Fadlalla (1974) reported that the mean digestibility coefficients of OM, CP and NFE were slightly improved by water restriction, also Mousa and Elkalifa (1992) reported that water deprivation improved nutrients digestibility.

During absence of adequate water the passage of ingesta through the digestive tract will slow passage of digesta through the alimentary tract allows more retention time for microbial utilization (Blaxter *et al*., 1956; Sha *et al*., 1987; and Asplund and Pfander, 1972) which result in a higher DMD contrary to the finding obtained in this study several researchers failed to find a significant increase in nutrients digestibility with water restriction as in sheep (Ahmed and Abdelatif, 1994, Hadjigeorgiou *et al*., 2000) and goats (Ahmed 2009, Silankove, 1987; Lutfi and Ahmed, 2010).
Feed restriction to about 33.3% of adlibitum highly significantly ($P<0.01$) decreased DMD, OMD, EED and NFED and significantly ($P<0.05$) decreased CPD, CFD and TDN. In line with this result Hassouna (2012)

obtained that the digestibility coefficients of various nutrients as well as TDN decreased (P<0.01) significantly with feed restriction also (Lutfi and Ahmed, 2010) reported that EED tended to decrease in response to feed restriction in goats when used Lucrene hay, also Ahmed and Elshafei, (2001) reported a significant decrease by feed restriction on TDN in desert goats feed Lucerne hay.

In contrast with these results many researchers (Taha, 2013; Ahmed, 2009; Varga and Prigge, 1982, Robinson *et al*., 1985 and Brun-Bellut *et al*., 1988) stated that imposing a reduction of up to 40% in food intake at near maintenance in goats, sheep and cattle, was found to be associated by no appreciable effect on the digestibility. (Lutfi and Ahmed, 2010) reported that EED tended to decrease in response to feed restriction which is in accord with the present study.

Decreased feed intake generally results in increased diet digestibility this considered to be a consequence of an increase in particle retention time in the rumen allowing more complete degradation of feeds by microbes (Robinson *et al*., 1987) this general integration is obtained at levels of intake higher than maintenance, however, in experiments in which the level of intake is decreased below maintenance level, the response of digestion to under-feeding has been variable (Doreau *et al*; 2003). In some cases, the general trend, i. e. increased digestibility is observed (Kabrḝ *et al*., 1995), but in other cases, digestibility did not vary (Doreau and Diawara, 2003). It is likely that at intake below maintenance, the increase in ruminal particle retention time dose not contribute to a better digestibility because at maintenance this retention time is long enough to optimize microbial degradation (Doreau *et al.*, 2003) Further more it thus seems that the reduction of particle size when intake decreases is less marked below maintenance than above maintenance and the increase in feed area available for enzymatic attack is not significantly modified (Hassouna, 2012).

Table (19): Apparent digestibility coefficients of nutrients and total digestible nutrients (TDN) as affected by water or feed restriction in Nubian goats:

Parameter	T_1	T_2	T_3	Sig.
DMD	82.06±4.61[b]	84.36±5.25[a]	65.10±11.29[c]	0.0019[**]
OMD	82.74±5.34[b]	85.70±4.14[a]	66.75±11.75[c]	0.0035[**]
CPD	89.09±2.57[b]	90.01±3.86[a]	78.91±5.84[c]	0.0449[*]
EED	54.33±21.04[b]	57.18±14.00[a]	30.83±10.44[c]	0.0072[**]
CFD	81.20±7.61[b]	84.30±4.18[a]	65.53±10.61[b]	0.0438[*]
NFED	72.36±16.91[b]	85.99±4.00[a]	66.00±12.32[b]	0.0067[**]
TDN	73.98±6.73[b]	77.39±3.87[a]	60.49±9.84[c]	0.0421[*]

Values are mean ±SD.

*is considered significant (P≤0.05)

** is considered highly significant at (P≤0.01)

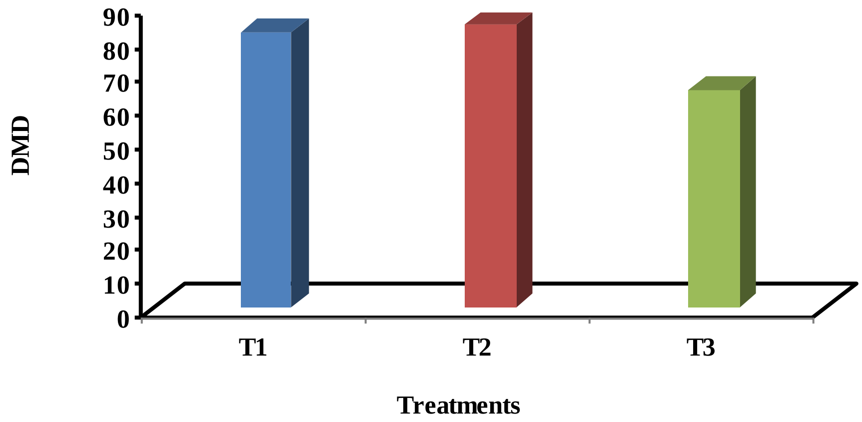

Fig. (57): DMD (Exp. IV)

Dry matter digestibility

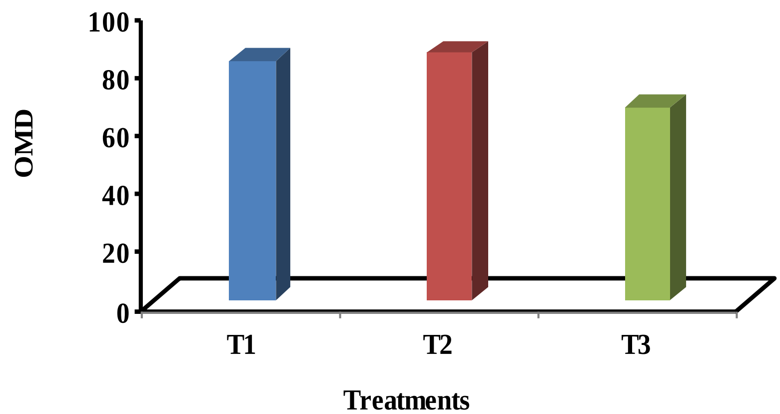

Fig. (58): OMD (Exp. IV)

Organic matter digestibility

Key

T_1 ≡ Feed adlib. and water adlib. (control)

T_2 ≡ water restricted to 33.3% from adlib. and feed adlib.

T_3 ≡ water adlib. and feed restricted to 33.3% from adlib.

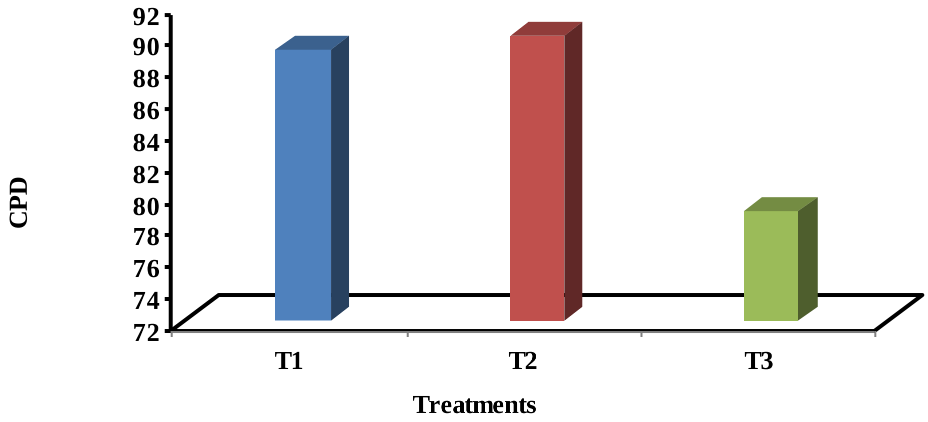

Fig. (59): CPD (Exp. IV)

Crude protein digestibility

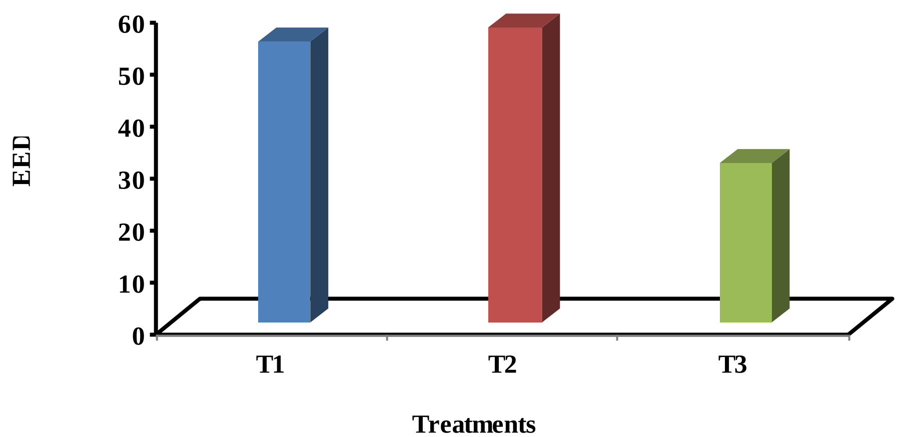

Fig. (60): EED (Exp. IV)

Ether extract digestibility

Key

T_1 ≡ Feed adlib. and water adlib. (control)
T_2 ≡ water restricted to 33.3% from adlib. and feed adlib.
T_3 ≡ water adlib. and feed restricted to 33.3% from adlib.

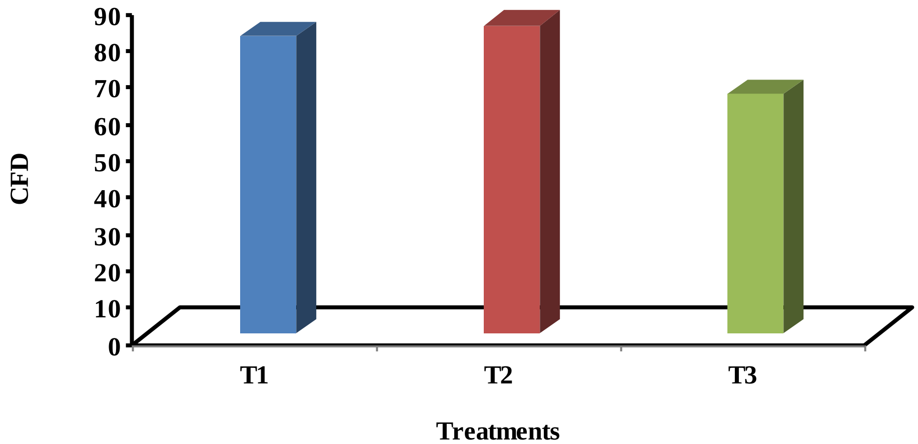

Fig. (61): CFD (Exp. IV)

Crude fibre digestibility

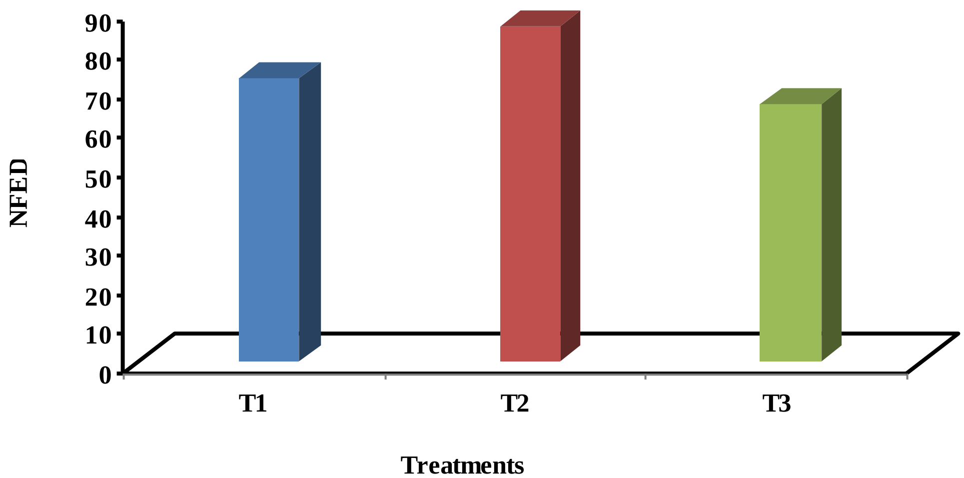

Fig. (62): NFED (Exp. IV)

Nitrogen free extract digestibility

Key

T_1 ≡ Feed adlib. and water adlib. (control)
T_2 ≡ water restricted to 33.3% from adlib. and feed adlib.
T_3 ≡ water adlib. and feed restricted to 33.3% from adlib.

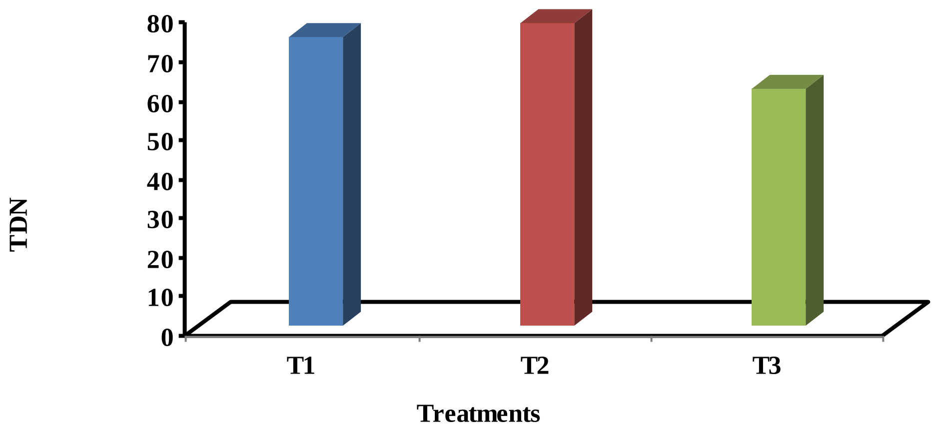

Fig. (63): TDN (Exp. IV)

Total digestible nutrients

<u>Key</u>

T_1 ≡ Feed adlib. and water adlib. (control)

T_2 ≡ water restricted to 33.3% from adlib. and feed adlib.

T_3 ≡ water adlib. and feed restricted to 33.3% from adlib.

4.4.3 Effect of water or feed restriction on the rumen fermentation products and BUN

The data for both ruminal components and BUN as affected by water or feed restriction are shown in table (20):

The ruminal pH was not affected by water restriction not by feed restriction. Water restriction did not affect (P>0.05) ruminal pH, this was in line with the finding obtained by (Hassouna, 2012) who reported that water restriction had no effect on ruminal pH but this is not in accord with the results obtained by (Ahmed and Abdelatif, 1994) who reported that water restriction significantly (P<0.05) decreased the pH, they attributed this reduction to reduction in rumen fluid volume; reduced salivary secretion and increase in the concentration of VFA in sheep.

Feed restriction in the present study was not affected (P>0.05) ruminal pH this result was in line with Ahmed (2009) and Taha (2013) they reported that rumen pH was not affected by feed restriction, Lutfi and Ahmed (2010) found the same results in Nubian goats subjected to 50% feed restriction also Patnayak and Leffel (1969) found that ruminal pH did not differ significantly due to level of intake. Contrary to this results reported by Hassouna (2012) when used desert sheep and Nubian goats subjected to 33.33% feed restriction found that pH was highly affected (P<0.01)by treatments, the same results obtained by Ahmed and Abdelatif (1994); in desert sheep subjected to feed restriction (32% of the adlibitum level). Ruminal NH_3-N was affected significantly (P<0.05) by food and water restriction it increased by water restriction and also increased by feed restriction before feeding but it decreased 6hrs after feeding. Ahmed and Abdelatif (1994) found that the rumen NH_3-N concentration increased significantly as a result of food restriction, contrary to this finding Hassouna (2012) and Doreau *et al*. (2004) observed a decreased in ruminal NH_3-N concentration at low intake or feed restriction, ruminal NH_3-N increased ($P<0.05$) significantly by water restriction, this was in contrast with the result of Hassouna (2012) who found that ruminal NH_3-N decreased ($P<0.01$) significantly with water restriction ruminal NH_3-N decreased ($P<0.05$) significantly 6hrs after feeding and tend to increased 3hrs after feeding. The same results obtained by Ahmed (2009) that NH_3-N concentration tended to increase 3hrs after feeding by feed restriction.

The NH_3-N concentration found in this investigation was higher than the ruminal NH_3-N concentration of 5 mg/100 ml reported by Satter and Slyter (1974) as being necessary for maximal protein synthesis. Owens and Bergen (1983) reported that concentration ranging from 3.5 to 29 mg/100ml promote maximal microbial growth.

Blood urea nitrogen was highly ($P<0.01$) significantly affected by treatments that they increased with water restriction and decreased with feed restriction this was in line with Ahmed (1989) who reported a significant increase in plasma urea level during water restriction also (Ahmed and Abdelatif, 1994; Burgos *et al*. 2001) reported that BUN increased with water restriction suggesting an increase in tissue protein catabolism and (or) a reduction in tissue protein synthesis (Cole *et al*. 1986). The increase in BUN is due to the greater water uptake to kidney and to the decreased blood flow towards the urinary apparatus that causes a reduction of urine and the increase of BUN concentration. (Casamassima *et al*., 2008). Cole and Hutcheson (1987) reported that plasma urea-N (PUN) increased (P<0.05) as a result of feed and water restriction, Casanassima *et al*., (2008) and Ahmed and Abdelatif (1994) showed insignificant increase (P>0.05) in PUN with feed restriction 32% of adlibitum. At low levels of N intake that accompanied either water or food restriction, recycling of urea is greatly enhanced.

Contrary to our results several researchers Hassouna (2012), Ahmed (1989), and, Lutfi and Ahmed (2010) reported that feed restriction did not affect (P>0.05) BUN. On the other hand Taha (2013) and Kannan *et al*., (2007) reported that BUN was not affected when used goats subjected to feed restriction. Doreau *et al*., (2003), and Caldeira *et al*., (2007) reported a direct affect of N intake on urea serum concentrations. Zanton and Heinrichs (2009) reported higher concentration of PUN with increasing N intake. Lutfi and Ahmed (2010) and Hassouna (2012) reported that BUN concentration was not affected by sampling time and this result was in line with the present result.

Table (20): Effect of water restriction 33.3% of adlibitum or feed restriction 33.3% from adlibitum in the rumen fermentation products and BUN:

Parameter	Time (hrs)	T_1	T_2	T_3	Sig.
pH	BF	7.08±0.15[a]	7.01±0.07[a]	6.84±0.30[a]	0.1358[NS]
	3	6.58±0.09[a]	6.61±0.17[a]	6.34±0.19[a]	0.2746[NS]
	6	6.52±0.32[a]	6.68±0.11[a]	6.24±0.20[a]	0.0981[NS]
NH_3-N	BF	21.95±22.52[b]	34.81±45.71[a]	34.78±45.19[a]	0.0325[*]
	3	30.01±35.37[b]	47.78±62.26[a]	30.87±34.81[b]	0.0426[*]
	6	34.22±47.51[b]	39.41±54.70[a]	28.70±35.95[c]	0.0409[**]
BUN	BF	42.97±29.33[b]	59.04±46.32[a]	33.11±23.04[c]	0.0027[**]
	3	47.67±33.29[b]	58.43±43.52[a]	31.23±21.49[c]	0.0038[**]
	6	43.91±32.92[b]	51.17±37.55[a]	35.17±22.81[c]	0.0015[**]

*is considered significant (P≤0.05)

** is considered highly significant at (P≤0.01)

NS = not significant

4.4.4 Effect of water or feed restriction on N-balance

The effect of water restriction 33.3% of adlibitum or feed restriction 33.3% of adlibitum, on N-balance are shown in table (21).

Nitrogen intake was significantly decreased by both treatments water and feed restriction, in line with this result Ahmed (1989) obtained that total amount of (N) ingested decreased significantly with both water and feed restriction also Ahmed and Abdelatif (1994) reported that feed restriction significantly decreased the N intake in desert rams fed concentrations to 32% of the adlibitum intake faceal nitrogen was not affected (P>0.05) significantly by treatments but tend to decrease insignificantly with both water and feed restriction, urinary nitrogen decreased significantly (P<0.05) with feed restriction and insignificantly (P>0.05) with water restriction also N-balance decreased significantly (P<0.05) by feed restriction and had a negative value whereby water restriction not affected (P>0.05) N-balance but it tend to decrease.

In line with these results were obtained by Hassouna (2012), Ahmed and Elshafei (2001) and Ahmed and Abdelatif (1994) who obtained a negative N-balance with feed restricted goats, and kamalzadeh (2004) in sheep. The negative N-balance observed with feed retricted animals indicated that N was not sufficient to meet the requirements of the animals in line with the present result Ahmed (1989) said that water restriction did not cause a significant change in the amount of N retained. On the other hand Hassouna (2012) reported that N-balance increased with water restriction also Walt *et al*., (1999) said that inadequate drinking leads to decreased N excretion and improved N retention, Yagil (1985) demonstrated that the positive N retention with water restriction in animals on good quality roughage might reflect adaptation to desert conditions whereby animals would acquire the ability to recycle N through the ruminal wall and saliva for microbial synthesis.

Nitrogen balance as % of intake and NB as % of digested were highly significantly affected by treatments ($P<0.01$), Taha (2013) obtained that there were no significant affects with feed restriction on NB as % of intake and NB as % of digested.

Table (21): Nitrogen balance as affected by water or feed restriction in Nubian goats:

Parameter	T_1	T_2	T_3	sig
Nitrogen intake g/d	15.86±11.70[a]	11.61±10.40[b]	5.83±2.95[c]	0.0385*
Faceal nitrogen g/d	2.29±0.97[a]	2.06±0.66[a]	1.81±0.86[a]	0.7462[NS]
Urinary nitrogen g/d	5.22±2.65[a]	5.19±0.80[a]	2.94±1.32[b]	0.0498*
Nitrogen balance g/d	14.09±1.39[a]	14.32±3.28[a]	-0.03±4.81[b]	0.0382*
NB as % of intake	61.94±7.12[b]	66.90±10.27[a]	-2.45±66.31[c]	0.0019**
NB as % of digested	69.45±6.09[b]	74.28±8.86[a]	-7.52±87.77[c]	0.0025**

Values are mean ±SD.

*is considered significant (P≤0.05)

** is considered highly significant at (P≤0.01)

NS = not significant

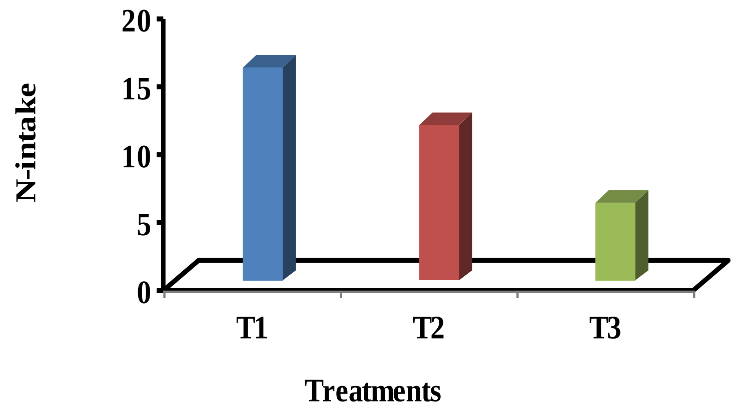

Fig. (64): NI (Exp. IV)

Nitrogen intake

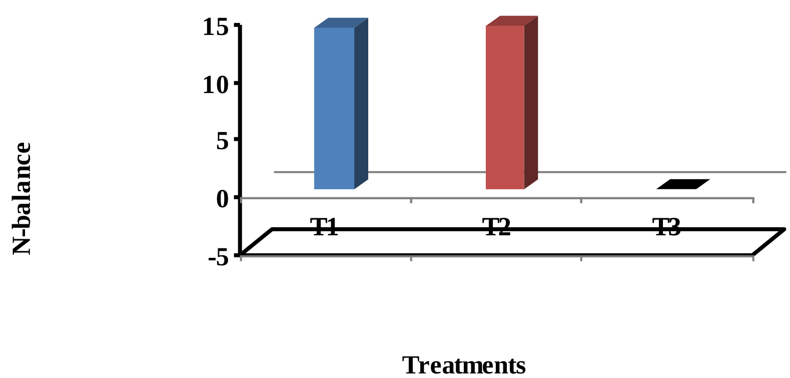

Fig. (65): Nitrogen balance

Key

T_1 ≡ Feed adlib. and water adlib. (control)

T_2 ≡ water restricted to 33.3% from adlib. and feed adlib.

T_3 ≡ water adlib. and feed restricted to 33.3% from adlib.

Conclusions and recommendations

- It was concluded that goats can be watered once in 72 hours without severe dehydration.
- The tolerance of Nubian goats to water restriction may be due to their ability to limit urine and faecal water excretion.
- Restricting the water intake of Nubian goats to 50% of their average daily water intake did not affect their maximum physiological capabilities as shown by lack of change in their heart rate and rectal temperature (RR-RT).
- Water restriction for short periods is rather beneficial in some aspects of digestion and N-metabolism in Nubian goats.
- This study pointed out to withstanding capability of Nubian goats to feed restriction.
- Also this study pointed out that feeding high content of protein (alfalfa hay) to Nubian goats increased DMI, digestibility and N-balance compared to low content (Abu 70).
- Water restriction and feed restriction are two stress factors, and the success of Nubian goats to react by adjusting their bodily conditions might be indication of endocrine reactions involving hypothalamus, pituitary and thyroid glands. So research in this area is highly recommended.
- Future studies are needed to investigate the effects of dehydration on productivity traits like milk yield and composition.

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