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| **The potential of rabbit meat marketing in Tizi-Ouzou area, Algeria**   | **Original Research, C19**<br>**Kadi S.A., Djellal F., Berchiche M.**<br>***Online J. Anim. Feed Res.*, 3(2): 96-100, 2013.**<br>**ABSTRACT:** *In Algeria, the raising of the rabbit for meat develops more and more these last years. Several segments of this young sector have been studied as the feeding and reproduction. However, the segment of marketing has not been approached yet. This paper provides an overview of the rabbit meat marketing system in the Tizi-Ouzou area. To meet this objective the descriptive survey method was employed, using a structured questionnaire to provide data on commercialization of rabbit meat. Butcheries (n=192 ), poulterers (n=49 ), restaurants (n=184 ) and hotels (n=11 ) were concerned. Rabbit meat is sold in 8.48% (n=37) of stores visited and do not sold in 91.51% (n=399) ones. It's marketed more cooked (restaurants and hotels) than fresh (butcheries and poulterers). 75.44% of respondents who do not sell rabbit meat justifies it by the lack of demand and 10.78% (n=43) because of its unavailability. Rabbits are bought from producers generally as whole carcasses (86.49%) of about 1.4 kg. In the butcheries and poulterers, rabbit meat is sold to consumers at an average price of 470 DA (1U$=95 DA). 44.56 kg of rabbit meat are sold per week. The marketing of this meat is fragmented, inefficient so its distribution chain is disorganized. Despite those problems, there are also opportunities for expansion of this market. Given the current low levels of consumption of rabbit meat, there is a potential for total consumption of this meat to increase substantially as production and availability increases. More attention must be given to the market outlets and promotions of rabbit meat in Tizi-Ouzou area.*<br>**Key words:** *Rabbit meat, Marketing, Tizi-Ouzou* | PDF<br>Watch Online |

## Nutrient utilization in buffalo bulls fed crop residue based rations

**Original Research, C20**
**Venkateswarlu S., Srinivas Kumar D. and Narendranath D.**
***Online J. Anim. Feed Res*., 3(2): 101-105, 2013.**

**ABSTRACT:** *In 4 x 4 LSD, four graded Murrah buffalo bulls (6 yrs; 353 ± 8.26 kg) were fed four iso-nitrogenous complete rations comprising of jowar stover (CR1), maize stover (CR2), red gram straw (CR3) and black gram straw (CR4) as roughage source and concentrate mixture in 60:40 proportion, to study the effect of feeding complete rations on nutrient utilization. The DM intake (kg/d) was similar in all the groups. The digestibility coefficients of DM, OM, CP, EE, CF, NDF, ADF, Cellulose and Hemi-cellulose were significantly (P<0.01) higher in buffalo bulls fed CR2 while NFE digestibility was higher (P<0.05) in CR3 when compared to those fed other complete rations. All the animals were in positive N, Ca and P balances. Further, the % DCP and % TDN were significantly higher (P<0.01) in buffalo bulls fed CR2. It could be concluded that maize stover compared to other crop residues could be a superior roughage source for inclusion in complete rations for feeding buffalo bulls.*
**Key words:** *Black Gram Straw, Buffalo Bulls, Complete Rations, Jowar Stover, Maize Stover, Nutrient Utilization, Red Gram Straw.*

## Features topography and macrostructure lymph nodes of Camels (*Camelus dromedarius*)

**Original Research, C21**
pii: S222877011300021-3
**Gavrylin P, Rahmoun DE, Lieshchova M, Benchadi H.**
***Online J. Anim. Feed Res*., 3(2): 106-110, 2013.**

**ABSTRACT:** *This study was conducted to investigate the special features of topography and macrostructure of some somatic and visceral lymph nodes of the dromedary (Camelus dromedarius). The result of the study demonstrated that the arrangement and the morphometric characteristics of some lymph nodes of camel correspond to the analogical indices of cattle. At the organ level, the lymph nodes of camel congregate; they are partially fused. A pattern of spatial orientation of these nodes is not established. Lymph nodes of dromedary (Camelus dromedarius) according to their topography and linear characteristics in general correspond to the similar nodes of cattle. The architecture of the lymph node dromedary (Camelus dromedarius) differs from that shown in the conventional patterns of other mammalian animals, generally formed of a plurality of aggregates, the latter are surrounded by a connective tissue which extends over the whole area surface lymph node and each cluster is a node itself. Vascular distribution in these lymphoid aggregates is relatively abundant and each node receives one or two afferent lymphatic's and is drained by four or five efferent lymphatic's. In approximately half of nodes examined, there was extra nodal communications between the lymphatic vessels (afferent and efferent), allowing to bypass the lymph node. Lymph nodes are characterized by their dromedary lobule appearance and size.*
**Key words:** *Lymph Nodes, Dromedary, Topography, Macrostructure*

## Heamatological and serum biochemical characteristics of cockerels fed graded levels of boiled sorrel seed meal

**Original Research, C22**
**Duwa H., Sale B. and Adegbolah T.A.**
***Online J. Anim. Feed Res*., 3(2): 111-115, 2013.**

**ABSTRACT:** *The effect of feeding graded levels of boiled sorrel seed meal (BSSM) at 0,15,30,45 and 60% as replacement for groundnut cake in the diet of 200 seven day old chicks of Isa brown x Goldline cockerel on heamatological and serum biochemical indices was assessed in a 14week feeding trial. Each treatment consisted of forty birds and was replicated four times with 10 birds per replicate in a completely randomized design. At the end of the experiment, blood samples were randomly collected from four birds in each group for heamatological and blood chemistry studies. BSSM at 60% significantly (P<0.05) increased the values of RBC, Hb, WBC, PCV and MCV although they were within normal ranges. Total protein and albumin were significantly (P<0.05) increased while creatinine was significantly (P<0.05) reduced by higher levels of BSSM in the diet. It was concluded that up to 60% of GNC can be replaced by BSSM in the diet of cockerels without adverse effects on blood characteristics.*
**Key words:** *Cockerels, Boiled Sorrel Seed Meal, Heamatology, Serum Biochemistry*

## The nutritional composition and acceptability of cacti (O*puntia ficus indica*)-legume mixed silage

**Original Research, C23**
**Gusha J., Katsande S., Zvinorova P.I. and Ncube S.**
***Online J. Anim. Feed Res*., 3(2): 116-120, 2013.**

**ABSTRACT:** *The potential of making silage using dry browse legume hay (Acacia angustissima, Leucaena leucocephala, Calliandra callothrysus and Macroptilium Atropurpureum) mixed with fresh cactus (Opuntia ficus-indica) for winter supplementation of veld grass was evaluated using the proximate, tannins and the pH analyses. Chemical analysis revealed that N values were significantly increased (P<0.05). The N levels were 3.72, 4.5, 4.05, and 2.5% DM for A. angustissima, L. leucocephala, C. callothrysus and M. atropurpureum respectively, which were higher when compared to silage made from cereals. The NDF and ADF values were slightly higher than those reported in literature for cereal silages. The DM level of cactus – browse silage was very good (41%DM) considering that cactus normally have less than 10% DM. The silage pH was within the reported range, ranging from 3.97 to 4.11 on a pH meter. This was a good indicator of silage quality considering that low pH inhibit undesirable microbial activities. The tannins levels were lower in the silages but significantly different (P<0.05) between browse legume species. Ensiling lowered the tannin levels in the silage compared to the individual browse legume tannin levels. This study concluded that purely on compositional laboratory analysis, the legumes and cactus can be used to make silage which can be used by farmers during dry season.*
**Key words:** *Opuntia ficus indica, Silage, Browse Legumes, Tannins, pH, Nitrogen*

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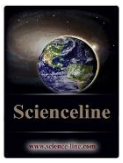


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# EFFECT OF DIFFERENT SALT CONCENTRATION ON TOTAL BACTERIAL COUNT AND HEAVY METAL COMPOSITION OF THE FISH *Hydrocynus spp.*

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**ABSTRACT:** *This piece of work was done in an attempt to evaluate the issue of the traditional fish salting practice in the Sudan. Fassiekh was selected as one of the widely consumed salted fish product, of great preference among Sudanese consumers. The study was directed towards the study of the heavy metal concentration and the microbiological analysis of fresh fish and fassiekh to compare the effect of the different salt concentrations. One kind of fish species preferable by Sudanese consumers in fasseikh making was selected for this study namely hydrocynus spp (kass). Samples were taken from Elmawrada fish market, and subjected to three salt concentration levels (15%, 20%and 25%) by weight to achieve the goals of the study. Fresh fish were carefully handled throughout the preparation process; they were eviscerated and cleaned up and divided in to two groups then three sup groups to be treated with different salt concentration. After the fermentation process sample were taken to do the heavy metal concentration analysis and microbiological analysis. It was observed that the heavy metal (Arsenic, Cadmium and lead) concentration were not significant. But the microbiological analysis result showed significant decrease in total bacterial count in all concentrations.*

ORIGINAL ARTICLE

**Key words:** *Heavy Metal, Bacteria, Fish, Salt.*

## INTRODUCTION

Fish is widely consumed in many parts of the world by humans because it has high protein content, low saturated fat and also content omega fatty acids known to support good health. Marine foods are very rich sources of mineral component (Sikorski et al., 1990). The global contribution of fish as a source of protein is high, ranging from 10% to 15% of the human food basket across the world (Wilson et al., 2007). Despite the fact that the nutritional value of fish is well known, it nevertheless plays only a limited role in the diet of many countries. Therefore, it would seem appropriate to find new processing methods for this compared valuable raw material so as to increase consumer interest. Compared to mammalian meat, fish meat has more water and less connective tissue, which contains very little elastin (Kolakowska, 2001).

Fish is most important source of meat that may play an appreciable role in solving food problem in the world especially in the developing countries (FAO, 1991). Fish and fishery products are highly nutritious, in addition to the high percentages of animal protein, they provide several other nutrients such as vitamins A and B especially in the liver, and E and K vitamins, and they are good sources of some minerals like Calcium, Phosphorus and Iron (Lunven, 1982).

Salting is one of the earliest techniques for preserving fish. Salting preserves by lowering the moisture content of the fish to the point where bacterial and enzymatic activities are retarded. Spoilage organisms generally can not survive long at salt contents of 6 to 8 (Wet basis of the fish) or higher (Wheaton and Lawson, 1985).

The major goal for the food processing industry is to provide safe, wholesome and acceptable food to the consumer. Control of microorganisms is essential in meeting this goal. This control is partly exerted through processing and preservation techniques that eliminate microorganisms or prevent their growth. It is also required that the basic hygienic level during processing is high and that efficient cleaning and disinfecting procedures that eliminate spoilage and bacteria are used. Many food pathogenic and spoilage bacteria are able to attach to food contact surfaces (Fonnesbech Vogel et al., 2001).

The objectives of this study were to assess:

1) The safety of the product by the microbiological parameters of both fresh *Hydrocynus spp* and *fessiekh.*

2) More details about fish salting and to know the effect of salting on the heavy metal concentration.



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## MATERIALS AND METHODS

### Sample collection

Fresh fish samples were collected from EL Mawrada fish market the samples was kass (*Hydrocynus spp*). A total of 6 kg each have about 100-110g stored In Iced container and transferred to the fisheries laboratory in Sudan university department of fisheries and wildlife biology for preparing and processing. Random samples were taken to do the chemical and microbiological analysis of fresh fish.

### Preparation and processing of fish

Preparing fassiekh takes place as follows: first fresh fishes were individually gutted and washed by tap water and placed on a plastic dishes to dry and then weighted on sensitive balance (FEJ-2000B).the addition of salt is made relevant to weight of the fish. To get the effect of salting of fish after processing, fish were devided in to tow group each have three kg, the first group for take the effect of salting on the product weight and the second to do the chemical and microbiological examination, each group divided in to three groups each group was about (1) Kg then subjected to a different salt concentration (15%, 20%, and 25%). Each fish was salted separately, with coarsely ground salt, applied all over the body with especially on the gill area and the cavity of the gutted specimens. Then the fish were stacked in layers separated by layers of salt on plastic container and covered with a heavy cover. The fish are thus left to undergo fermentation for (10) days.

### Random sample were taken on the 10$^{th}$ day to do microbiological and chemical analysis

Bacteriological examinations: Fresh and salted fish was analyzed for the determination of the total count of bacteria.

### Culture media used

**Aerobic Plate Count:** It is a simple media. Is to be prepared according to manufactures instructions by suspending 20.1 grams of the powder in one liter of distilled water, boiling until dissolved completely and then sterilizing by autoclaving at 121 C$^0$for 15 min.

**Serial dilution:** 1 gram of fish was added to warm 37 C$^0$ (9) ml normal saline then shook well to distribute all the organism within test tube. Then one ml from previous mixture (fish +normal saline) was transferred with a sterile 1 ml graduated pipette to 9 ml sterile normal saline in screw – capped bottle (Bijout bottles) and then mixed thoroughly. Using another sterile pipette, one ml of the dilution prepared was transferred to a second bottle and the process was repeated to make ten fold dilutions as described by Harrigan and MacCance (1976).

### Total Bacterial Counts

Total bacterial count in the fresh and salted samples was determined a sterile pipette was used to transfer 1 ml of the selected dilution into duplicate sterile plates. Nutrient agar was used. The plates were incubated at 37 C$^0$ for 48 hours; Colonies were counted.

### Determination of minerals

The heavy metal (lead, cadmium, arsenic) were determined by (perkin Elmer A (Analyst 700) Atomic Absorption Spectrophotometer following the method described by the manufacture.

### Statistical analysis

Results were analyzed using the SPSS computer program / one way (ANOVA).

## RESULTS

Table 1 shows Heavy metals content (mg/100g) of fresh fish and *fassiekh* with different salt concentration (15%, 20%and 25%) expressed on wet matter basis.

**Table 1 -** The effect of salt concentration level on heavy metal contents of *hydrocynus spp.*

| Salt (%) / Parameters | 0 | 15 | 20 | 25 | Significance |
|---|---|---|---|---|---|
| Arsenic | 0.199±0.13 | 0.201±0.05 | 0.201±0.05 | 0.204±0.00 | NS |
| Cadmium | 0.175±0.00 | 0.181±0.04 | 0.179±0.00 | 0.182±0.03 | NS |
| Lead | 0.324±0.05 | 0.326±0.05 | 0.326±0.05 | 0.326 ±0.05 | NS |

NS: not significant

### Microbiological analysis

Table 2 shows the total bacterial count of fresh *(Hydrocynus spp.)* fish and *fassiekh* with different salt concentration (15%, 20%and 25%; After 10 days) by CFU/gm.



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**Table 2 -** The effect of salt concentration level on the total bacterial count of *hydrocynus Spp.*

| Parameter / Salt (%) | Total plate count (TPC) |
|---|---|
| 0 | $58.1\times10^3 \pm 21.1\times10^3$ [a] |
| 15 | $10\times10^3 \pm 1\times10^3$ [b] |
| 20 | $7.8\times10^3 \pm 0.76\times10^3$ [b] |
| 25 | $4\times10^3 \pm 1\times10^3$ [b] |
| Significance | * |

* Significant at (P≤0.05). [a,b] means within the same column followed by the different superscript are significantly (P≤0.05) different. The total bacterial count of fresh fish is $58.1\times10^3$ and in fassiekh with (15%, 20%and 25%) salt concentration is $10\times10^3$, $7.8\times10^3$ and $4\times10^3$, respectively.

## DISCUSSION

### Arsenic content

The arsenic content of fresh fish and salted fish (15%.20%, and 25%) under investigation were 0.199 and 0.0201, 0.201, and 0.204 mg/100g respectively. this result is lower than that reported by (Sivaperumal et al., 2007) who found the arsenic content in *Etroplus ssuratensis* about 1.515 mg/kg. Salting and fermentation not affected significantly (P<0.05) the arsenic content in the product.

### Cadmium content

The cadmium content of fresh fish and salted fish (15%, 20% and 25%) under investigation were 0.175 and 0.181, 0.179, 0.182 mg/100g respectively the permissible limit for Cadmium in sea bass is 0.1 mg/kg wet weight (EC, 2001). Salting and fermentation treatment not affected cadmium value at (P<0.05).

### Lead content

The lead content of fresh fish and salted fish (15%, 20%25%) under investigation were 0.324and 0.330, 0.477, and0.464 mg/100g respectively. This result is lower than that reported by (Dural et al., 2007) who found that the lead content about 0.40–2.44 mg $kg^{-1}$ for muscles and 1.41–3.92 mg $kg^{-1}$ for livers of fish from Tuzla Lagoon . Salting and fermentation treatments not affected lead value at (P<0.05).

### Microbiological parameters

Table 2 shows the total bacterial count values of fresh *hydrocynus spp* fish and *fassiekh* with (15%, 20% and 25%). The data showed significant different, the highest value ($58.17\times10^3$) was reported in fresh fish, while the lowest value ($4\times10^3$) was reported in fassiekh with 25% salt concentration after 10 days .this result is lower than that reported by (Vishwanath et al., 1998 ) who found the total plate count of bacteria in fresh *Monopterus albus* about ($1.2\times10^{-6}$ $1.0\times10^{-7}$). This decrease in total bacterial count may be due to the presence of high salt concentration in fessiekh so the pathogenic microorganism growth is controlled.

Also this result is in agreement with the findings of (El-Tom, 1989 and Abu Giddeire 2001) who reported that the count of microorganism increased rapidly during first fermentation days and began to decrease later. And in agreement with Ahmed (2006).

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# EFFECT OF DIETARY RAW CHICKPEA (*Cicer arietinum* L.) SEEDS REPLACEMENT GROUNDNUT MEAL, SESAME MEAL ON BROILER PERFORMANCE AND BLOOD CONSTITUENTS

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**ABSTRACT:** *This study was conducted to investigate the effect of chickpea seeds on performance and blood constituents of broilers. One hundred and twenty eight unsexed one day old (Ross) broiler chicks were randomly assigned to four approximately isocaloric and isonitrogenous diets labeled as follows: Diet (F0) containing 0% chickpea (control diet), diet (F1) 10% chickpea substitute same levels of sesame meal and groundnuts meal, diet (F2) 10% chickpea substitute from groundnuts meal only and diet (F3) 10% chickpea substitute from sesame meal only. Each treatment had four replicates with 8 birds/ replicate. The study lasted for 8 weeks. Parameters Measured were feed intake, body weight gain, feed conversion ratio (FCR), pre –slaughter weight, dressing percentage, protein efficiency, some blood parameters (glucose, cholesterol, triglyceride, total protein, calcium, and phosphorus) and profitability. The results showed significant decrease (P<0.05) in feed intake) for birds consumed the diets supplemented with chickpeas than control. Body weight gain, pre slaughter weight and carcass weight were significantly (P<0.05) greater for birds received diet F0 (1527.37g), (1615.49g), (1195.32g) respectively and diet F3 (1430.80g), (1472.29g), (1072.06g) respectively and lower for birds received diet F2 (937.71g), (761.58g) and (533.29g) respectively. No significant differences were observed in feed conversion ratio and protein efficiency ratio among all dietary treatments. Broiler chicks received diet F2 recorded significantly (P<0.05) poorer dressing percentage than other treated diets. All the treatments had no significant (P>0.05) effect on serum glucose, cholesterol, triglyceride, total protein, calcium and inorganic phosphorus levels. Broiler chicks received diet F3 recorded the highest profitability than other groups.*

**Key words:** *Chickpeas, Broilers, Performance, Carcass, Characteristics*

ORIGINAL ARTICLE

## INTRODUCTION

Food legumes have been well recognized as valuable source of dietary proteins in many parts of the world. A major portion of the world population relies on legumes as staple food particularly in combination with cereals. (Nalaini, 2005). Chickpea is a food legume crop grown in tropical, sub-tropical and temperate regions. Chickpea is the 2nd most important pulse crop in the world, accounting for 14% (FAO, 1998) of world pulse production (Singh et al., 1991) Peas contain between 220 and 270 g/Kg crude protein and have an amino acid profile which is relatively well balanced (Canibe et al., 1997) although like many grain legumes, the protein is marginal in the sulphur amino acids (Perez et al., 1999). The protein concentration in pea is lower than lupine, soybeans or oilseed meals, the metabolizable energy is generally higher (Cowieson et al., 2001). To date the poultry industry has been reluctant to use these products in broiler diets due to suspected presence of anti-nutritional factors and very limited information on possible inclusion levels of untreated grains. Like other legumes, chickpea seeds contain varieties of anti-nutritional factors such as protease and amylase inhibitors, lectins, polyphenole and oligosaccharides (Yutste et al., 1991 and Cerioli et al., 1998) which impair nutrient absorption from the gastrointestinal tract and can result in detrimental effects on animal health and growth (Chavan et al., 1989; Perez et al., 1999) Increasing the proportion of chickpea seed in the broiler diet negatively influenced body weight gain, food intake and food efficiency (Farrel, 1999; Viveros et al., 2001; Pisulewska et al., 2000). In comparison to soybean (*Glycine max* L.), peas (*Pisum sativum* L.) and common beans (*Phaseolus vulgaris* L.), chickpea offers less problems as far as these factors (ANF) are concerned (Singh, 1988). Chickpeas are also a good source of dietary minerals, such as calcium,



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phosphorus, magnesium, iron, and potassium (Chavan et al., 1989). The objective of this study is to assess the effect of feeding row chickpea seed replacement sesame meal and groundnuts meal on the broilers performance and blood constituents also to study the economic benefits.

## MATERIALS AND METHODS

### Experimental birds and design

One hundred and twenty Eight day-old unsexed commercial broilers chicks (Ross) were used for this study the initial weight of birds ranged 37- 45 g The chicks were randomly assigned to the four experimental diets 32birds per treatment group in a completely randomize design each treatment group was further subdivided into four replicates of 8 birds.

### Experimental diets

The experimental diets were calculated to meet the nutrient requirement of broiler chicks according to the National Research Council (1994). Four iso energetic and iso nitrogenous diets were formulated as follows: Diet (F0) containing 0% chickpea (control diet), diet (F1) 10% chickpea substitute same levels of sesame meal and groundnuts meal, diet (F2) 10% chickpea substitute from groundnuts meal only and diet (F3) 10% chickpea substitute from sesame meal only. The composition and the calculated analysis of the experimental diets are shown in Table 2.

**Table 1 -** Proximate analysis and anti-nutritional factors of chickpeas seeds

| Items | Chickpeas seed |
|---|---|
| Dry matter | 93.10 |
| Either extractives | 3.78 |
| Crude protein | 24.31 |
| Crude fiber | 13.57 |
| Ash | 3.02 |
| Nitrogen free extractives | 48.41 |
| Tannin | 0.06 |
| Poly phenol | 0.03 |
| Phytic acid | 0.64 |
| Digestibility | 83.38 |
| ME (kcal/kg) | 2540 |

ME = Calculated according to equation of Lodhi et al. (1976)

**Table 2 -** Percentage composition and calculate analysis of rations

| Feed staffs % | Diets | | | |
|---|---|---|---|---|
| | F0 | F1 | F2 | F3 |
| Sorghum | 65.00 | 63.21 | 63.21 | 63.21 |
| Groundnut meal | 13.00 | 10.00 | 00.00 | 20.00 |
| Sesame meal | 12.00 | 10.00 | 20.00 | 0000. |
| Chickpea | 00.00 | 10.00 | 10.00 | 10.00 |
| Wheat brand | 3.21 | 0000 | 0000 | 00.00 |
| Super concentrate | 05.00 | 05.00 | 05.00 | 05.00 |
| Di-calcium phosphate | 01.25 | 01.25 | 01.25 | 01.25 |
| Methionine | 0.000 | 0000 | 00.00 | 00.00 |
| Lysine | 00.04 | 00.04 | 00.04 | 00.04 |
| Premix[1] | 00.25 | 00.25 | 00.25 | 00.25 |
| Salt | 00.25 | 00.25 | 00.25 | 00.25 |
| **Calculated analysis %** | | | | |
| ME (kcal/kg) diet | 3089 | 3083 | 3087 | 3087 |
| Crud protein | 21.90 | 21.31 | 21.11 | 21.51 |
| Crud fiber | 3.393 | 3.997 | 3.025 | 4.969 |
| Calcium | 0.985 | 0.949 | 1.083 | 0.805 |
| Available phosphorus | 0.557 | 0.542 | 0.554 | 0.54 |
| Lysine | 1.076 | 0.996 | 0.961 | 1.031 |
| Methionine | 0.460 | 0.412 | 0.489 | 0.355 |

[1]provided per kg of diets: vitamin A 8000 IU, vitamin D3 1400 IU, vitamin E 2IU, vitamin K3 2 mg, vitamin B2 4 mg, vitamin B1 2 mg, Ca – d–pantothenate 5 mg, Nicotin amide 15 mg, Choline chloride 100 mg, Folic acid 0.5 mg, vitamin B12 5mcg, Iron 22 mg, Manganese 33 mg, Copper 2.2 mg, Cobalt 0.5 mg, Zinc 25 mg, Iodine 1.1mg. F0) chickpea 0% (control); F1) chickpea 10%, groundnut meal 10% and sesame meal 10%; F2) chickpea 10% and sesame meal 20%; F3) chickpea 10% and groundnut meal 20%



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### Management and data collection

The chicks were reared in deep litter with feed and water supplied ad-libitum. The birds were vaccinated against Newcastle disease at 7day-old (IB) and at the 28 day (lasota) > Gumboro disease vaccine was given at the 21 day. Vitamins offered as supportive does before and after vaccination Measurements taken were feed intake, weigh gain and feed conversion ratio. At the end of experimental period 4 birds from each replicate of each dietary treatment were randomly selected and weighted individually then slaughtered and allowed to bleed. Samples of blood were collected into clean dry test tube and allowed to clot and serum was separated and collected for frozen and later analyzed. Carcasses weight was recorded and the dressing percentage was determined by expressing carcass weight to the live weight. Protein efficiency ratio calculated as weight gain divided by protein intake.

### Statistical analysis

The data collected were subjected to analysis of variance and the means were separated using Duncan's Multiple Range test as described by Steel and Torrie (1980).

## RESULTS AND DISCUSSION

The effects of dietary treatments on feed intake, body weight gain, pre slaughter weight, carcass weight, feed conversion ratio (FCR), protein efficiency ratio (PER) and dressing percentage are shown in Table 3. Results revealed that treatment had significant ($P<0.05$) on feed intake. Birds consumed the diets supplemented with chickpeas reduced feed intake, this result may attributed to the palatability of those diets or may affected by tannins in legume grains. Birds received the diet F2 (contained 20% sesame meal) significantly ($P<0.05$) observed the lowest feed intake. The results of the current study are congruence with Linfield et al. (1985); Ali et al. (2000) and Godber et al. (1993) who reported that rancidity deteriorated the palatability and feed intake, also Hussein et al. (1982) and Award et al. (1988) reported reduction in feed intake for birds fed rations having rancid feed with high level. Weight gain, pre-slaughter weigh, carcass weight and dressing percentage were significantly ($P<0.05$) influenced by the treatments. Birds fed diet F2 (chickpea with sesame meal) had negative effect on these parameters and that may related to low feed intake of this group or may attributed to the rancidity of sesame, this result agree with the findings of Anjum et al. (2004). Chicks showed poor growth performance when dietary rice bran was rancid and other oxidized metabolites (Wang et al., 1997), thiobarbituric acid and acid values (Waheed, et al., 2004; Award et al., 1983; Miyazawa et al., 1986). Lower weight gain of birds fed OSO was generally similarly to earlier reports (Cabel et al., 1988; Lin et al., 1989; Engberg, et al., 1996; Wang et al., 1997). Chae et al. (2002) also reported lesser weight gain in chicks fed rancid rice polish compared to the chicks fed fresh rice polish. This might be due to destruction of fat-soluble vitamins in rancid oil that leads to reduced availability of nutrients as well as immunity and consequently depressed growth performance (Lin et al., 1989; Cheeke, 1991). Feed conversion ratio and protein efficiency ratio were not significantly ($P>0.05$) affected by inclusion of chickpea seeds. This result was similar with the finding reported by Christodoulou et al. (2006). Partial replacement of soybean with chickpeas at inclusion levels up to 12% of concentrate mixture as the main protein source in diets of broiler chickens resulted in similar productive performance. Brenes (2008) also demonstrated that the inclusion of graded concentrations of chickpea in chicken diets did not affect bird's performance. These results are in agreement with those reported by Viveros et al. (2001) and Farrell et al. (1999) who found a negative effect when chickpea was included up to 360 g kg-1 in the diet these differences might be due to the inclusion level or chickpea varieties used. However, Johnson et al. (1990) did not observe differences in performance of birds fed with 200 g chickpea kg-1. These discrepancies could be due to the presence of certain amounts of anti-nutritional factors in the seed, which can vary considerably among batches of the same legume (Saini et al., 1992). Although the inclusion of graded concentration of chickpea did not cause growth depression (Brenes, 2008)

The findings of the present study on serum components (Table 4) indicated that there were no significant ($P>0.05$) influenced for serum glucose, cholesterol, triglyceride, total protein, calcium, and inorganic phosphorus by the dietary treatments, this result agrees with findings reported by (Taguia, 2003). Feeding economics of experimental diets are presented in Table 5. The result showed that diet F2 (contained 10% chickpea with 20% sesame meal) is cheapest one but the broiler chicks received diet F3 (contained 10% chickpea with 20% groundnut meal) recorded the highest profitability than other groups.

**Table 3 -** The effect of feeding chickpea levels on overall performance of broiler chicks

| Items | Diets | | | | |
|---|---|---|---|---|---|
| | F0 | F1 | F2 | F3 | ±SEM |
| Feed intake g/bird | 3360.15$^{a}$ | 2841.96$^{b}$ | 2090.65$^{c}$ | 2912.65$^{b}$ | 60.74 |
| Weight gain g/bird | 1527.37$^{a}$ | 1311.42$^{b}$ | 937.71$^{c}$ | 1430.80$^{a}$ | 33.47 |
| Pre-slaughter g/bird | 1615.49$^{a}$ | 1280.98$^{b}$ | 761.58$^{c}$ | 1472.29$^{a}$ | 66.75 |
| Carcass weight | 1195.32$^{a}$ | 907.36$^{b}$ | 533.29$^{c}$ | 172.06$^{a}$ | 50.67 |
| Feed conversion ratio | 2.20 | 2.17 | 2.24 | 2.05 | 0.08 |
| Protein efficiency ratio | 2.03 | 2.10 | 2.04 | 2.15 | 0.06 |
| Dressing percentage | 73.96$^{a}$ | 70.83$^{bc}$ | 69.69$^{c}$ | 72.73$^{ab}$ | 0.91 |

$^{a, b, c:}$ values within a row with different superscripts differ significantly. SEM= Standard error of the mean.



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**Table 4** - The effect of feeding chickpea seeds on serum composition of broiler chicks

| Items | Diets | | | | |
|---|---|---|---|---|---|
| | F0 | F1 | F2 | F3 | ±SEM |
| Glucose | 162.88 | 159.75 | 170.00 | 180.13 | 12.49 |
| Cholesterol | 110.00 | 13.25 | 116.25 | 111.25 | 9.84 |
| Triglyceride | 86.63 | 92.38 | 72.13 | 90.13 | 12.24 |
| Total proteins | 3.16 | 3.40 | 2.91 | 3.15 | 0.19 |
| Calcium | 10.76 | 10.98 | 12.38 | 11.80 | 0.63 |
| Phosphorus | 14.29 | 14.00 | 14.70 | 14.34 | 0.50 |

**Table 5** - The feeding economics of experimental diets

| Items | Diets | | | |
|---|---|---|---|---|
| | F0 | F1 | F2 | F3 |
| Feed cost per bird (SDG) | 04.35 | 04.26 | 03.12 | 04.38 |
| Feed cost per bird ($) | 01.58 | 01.55 | 01.13 | 01.59 |
| Average weight of bird (kg) | 01.20 | 0.91 | 0.53 | 01.21 |
| Total returns (SDG) | 13.15 | 9.98 | 5.87 | 13.28 |
| Total returns ($) | 04.78 | 03.63 | 02.13 | 04.83 |
| Total cost per bird (SDG) | 07.35 | 07.26 | 06.12 | 07.38 |
| Total cost per bird ($) | 02.67 | 02.64 | 02.23 | 02.68 |
| Net profit per bird (SDG) | 05.79 | 02.72 | -0.25 | 02.90 |
| Net profit per bird ($) | 02.11 | 0.99 | -0.09 | 02.14 |

## CONCLUSION

Chickpea seeds could replace sesame by 10% with no adverse effect on bird performance, blood serum constituents and feed cost.

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# THE POTENTIAL OF RABBIT MEAT MARKETING IN Tizi-Ouzou AREA, ALGERIA

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**ABSTRACT:** *In Algeria, the raising of the rabbit for meat develops more and more these last years. Several segments of this young sector have been studied as the feeding and reproduction. However, the segment of marketing has not been approached yet. This paper provides an overview of the rabbit meat marketing system in the Tizi-Ouzou area. To meet this objective the descriptive survey method was employed, using a structured questionnaire to provide data on commercialization of rabbit meat. Butcheries (n=192), poulterers (n=49), restaurants (n=184) and hotels (n=11) were concerned. Rabbit meat is sold in 8.48% (n=37) of stores visited and do not sold in 91.51% (n=399) ones. It's marketed more cooked (restaurants and hotels) than fresh (butcheries and poulterers). 75.44% of respondents who do not sell rabbit meat justifies it by the lack of demand and 10.78% (n=43) because of its unavailability. Rabbits are bought from producers generally as whole carcasses (86.49%) of about 1.4 kg. In the butcheries and poulterers, rabbit meat is sold to consumers at an average price of 470 DA (1U$=95 DA). 44.56 kg of rabbit meat are sold per week. The marketing of this meat is fragmented, inefficient so its distribution chain is disorganized. Despite those problems, there are also opportunities for expansion of this market. Given the current low levels of consumption of rabbit meat, there is a potential for total consumption of this meat to increase substantially as production and availability increases. More attention must be given to the market outlets and promotions of rabbit meat in Tizi-Ouzou area.*

ORIGINAL ARTICLE

**Key words:** *Rabbit meat, Marketing, Tizi-Ouzou*

## INTRODUCTION

The raising of rabbit always existed in Algeria. In traditional production system until there and in modern system these last years, rabbit production actively participates in the reduction of the animal protein shortage of the population (Gacem and Lebas, 2000). While efforts have been taken to promote rabbit production in rational level (Gacem et al., 2008; Berchiche et al., 2012; Kadi et al., 2012).

In Algeria, rabbit production is concentrated mainly in the east and center of the country and Tizi-Ouzou is the highest production region of rabbit meat. Those last years, a pilot project has been carried out in Tizi-Ouzou: Formation of the young breeders before the creation of the rabbit unit, creation of the raising facilities with local materials and distribution of 16 does + 2 males for each unit. In spite of the encountered problems, part of these units continues to work and to produce rabbit (Zerrouki et al., 2005a; Kadi et al., 2012).

Meat market in Algeria is very complex (Sadoud, 2011; Sadoud and Chehat, 2011) and the literature on its operation is limited. The publications which relates to rabbit marketing are non-existent. To date, much of the research on rabbits carried out in Tizi-Ouzou University has centred on production practices. No market assessment studies are undertaken. In assessing the market for an infrequently consumed commodity, such as rabbit meat, the actions of both users and nonusers must be evaluated.

The aim of this paper is to investigate rabbit meat marketing in the wilaya (district) of Tizi-Ouzou.

## MATERIALS AND METHODS

The aim of this survey was to investigate rabbit meat marketing in the wilaya of Tizi-Ouzou (a wilaya = a geopolitical district). Tizi-Ouzou is the fifteenth wilaya among the forty eight that contains Algeria (see the official web site http://www.tiziouzou-dz.com/). It is located in the Northeast at about hundred km from the capital Algiers



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(Figure 1). To meet this objective the descriptive survey method was employed, using a structured questionnaire to provide data on commercialization of rabbit meat. The questionnaires aimed the butcheries (n=192 representing 67.3% of the total of butcheries), poulterers (n=49 representing 30.6% of the total poulterers), restaurants (n=184 representing 43.4% of the total ones) and hotels (n=11 representing 25.5% of the total ones). The questions were about the presence mainly or not of this meat and in particular on the frequency of the demand by the clientele, the sources and places of provisioning, weight and price of the carcasses, profile of the consumers, quantities used during the week. The data obtained from the questionnaires were organised by coding the open-ended questions, in order to prepare them for data capturing.

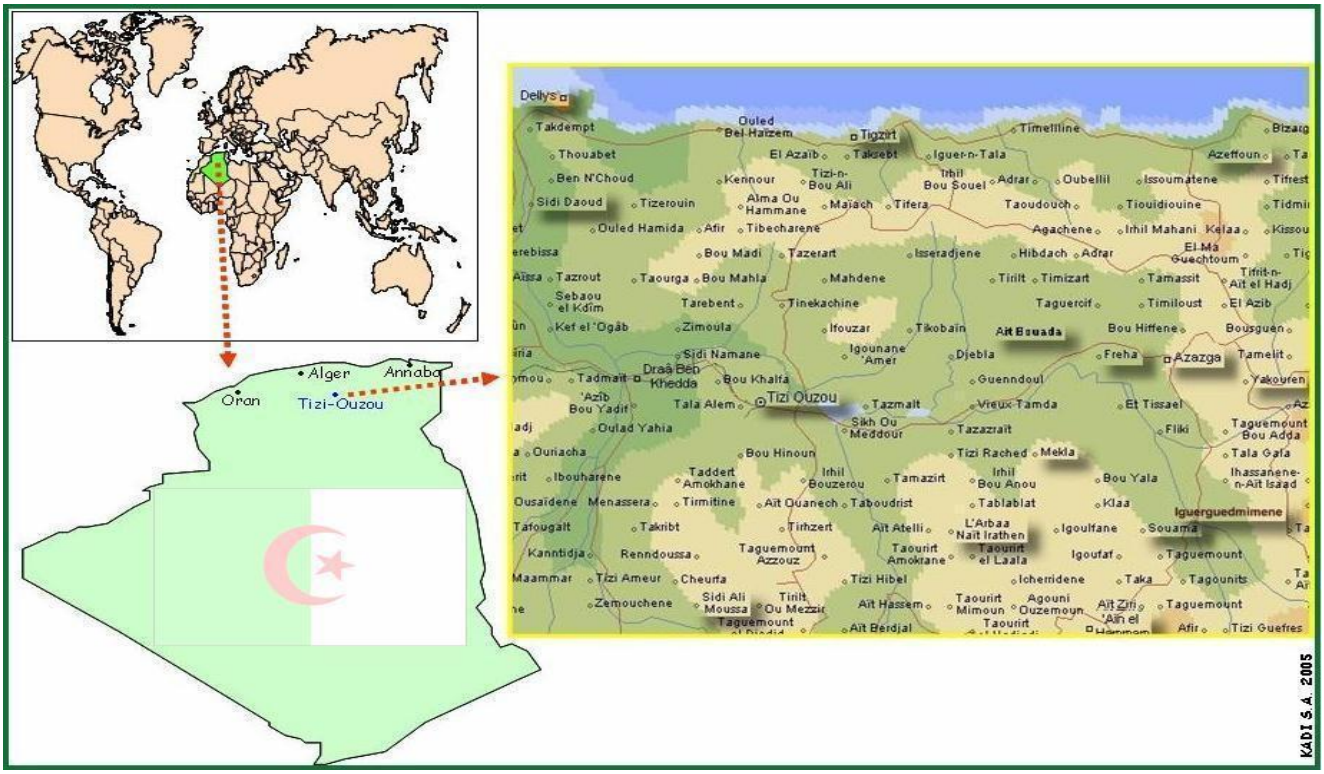


**Figure 1 -** Localisation of Tizi-Ouzou region, the study area

### Statistical analysis

All data were entered into a Microsoft Excel spreadsheet with, in lines, the different questionnaires and, in columns, the explanatory and explained variables represented by the different questions. The quantitative data were subjected to the 6.4 version of the STATBOX package for determining descriptive statistics (means, standard deviations, frequencies and percentages). The statistical significance level of differences between the dependent and independent variables were determined by Chi-square tests at $P<0.05$.

## RESULTS AND DISCUSSION

### Marketing of rabbit meat

According to the results, only 8.48% (n=37) of the respondents in the wilaya of Tizi-Ouzou market the rabbit meat (Table 1). The two most important markets for commercially produced rabbit are retail poulterers in metropolitan markets and restaurants often high-end ones. Rabbit's meat is mostly marketed cooked (restaurant and hotels) than fresh (Butcheries and Poulterers); because of its time consuming preparation which requires culinary skills. This situation is also observed in the wilayas of Constantine and Algiers by Gacem and Lebas (2000). So, there is a real challenge for food technologists, especially cooks, to put in point receipts incorporating the rabbit meat and fulfilling the requirements of the local consumers.

Fresh rabbit meat can also be sold directly to the consumer as it is the case in the rural areas. In these regions where the type of rabbit raising is traditional (Berchiche and Lebas, 1994), the primary objective for rabbit production is to provide a source of meat for the family (Djellal et al., 2006). Only the surplus of rabbits is sold as meat for consumer or as breeding stock to neighbours, friends and local clients but rarely at the weekly markets.

A majority of respondents (75.44%) who do not sell rabbit meat justifies it by the lack of demand (Table 2). However, 10.78% (n=43) does not sell it because of its unavailability. Indeed, the lack of consumer acceptance of the product has little impact upon the market because rabbit production has not saturated the market. Current demand for rabbit meat exceeds supply, so consumer acceptance is not a problem.


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**Table 1** - Marketing of rabbit's meat according to the type of store in the wilaya of Tizi-Ouzou

| Type of store | Total number in the region | Number of stores investigated | Sells the rabbit's meat (number and percent) | Don't sells the rabbit's meat (number and percent ) |
|---|---|---|---|---|
| Butcheries | 285 | 192 | 03 (1.56%) | 189 (98.44%) |
| Poulterers | 163 | 49 | 10 (20.41%) | 39 (79.59%) |
| Restaurants | 423 | 184 | 20 (10.86%) | 164 (89.13%) |
| Hotels | 43 | 11 | 04 (36.36%) | 7 (63.64%) |
| Total | 914 | 436 | 37 (8.48%) | 399 (91.51%) |

Moreover, contrary to the generally accepted ideas, on the level of the area of study, people having negative attitude to rabbit meat or refuse consumption for emotional reasons is weak (Kadi, 2007). In addition, there are no religious apprehensions since Islam (principal religion in the area) does not prohibit the consumption of the rabbit meat. However, motivations for no consuming this meat are globally the same than that reported by several authors in different regions through the world (Hui and McLean-Meyinsse, 1996; McLean-Meyinsse, 2000; Hoffman et al., 2004; Olivares et al., 2004; Hoffman et al., 2005).

**Table 2** - Reasons for which the rabbit meat is not sold

| Reasons evoked | Number of respondents | Proportion (%) |
|---|---|---|
| Not asked for by the customers | 301 | 75.44 |
| Traditions | 20 | 5.01 |
| Expensive | 18 | 4.51 |
| Unavailable | 43 | 10.78 |
| It resembles to the cat | 2 | 0.50 |
| Without idea | 15 | 3.76 |

**Format of rabbit meat and source of provisioning**

Rabbits are marketed live or killed to Butcheries, Poulterers and restaurants (Table 3). They are bought from producers generally as whole carcasses (86.49%) of about 1.4±0.5 kg. Whole carcasses include head, thoracic content (heart, lungs…), liver, kidneys and extremities of the legs and the corresponding skin. The offals are thrown. The weight of carcasses (1.4±0.5 kg) seems interesting compared to the modest growth performances of this population (Kadi and Berchiche, 2002). For indication, on the level of French market, the average carcass weighs 1.4 kg (Lebas, 2003).

**Table 3** - State of rabbits to the purchase

| Reasons evoked | Number of respondents | Proportion (%) |
|---|---|---|
| Alive | 5 | 13.51 |
| Slaughtered | 32 | 86.49 |

There is no slaughter-house specialized in the slaughtering of rabbits in the area of study. The rabbits are slaughtered by cutting the jugular vein with a sharp knife and stripped into the rabbiteries. Present country laws do not require veterinary inspection of rabbit processing or of rabbit meat before it can be sold in retail outlets. So, the rabbit producer is responsible for ensuring that the rabbit meat sold is wholesome and properly handled prior to delivery. As well as the butchers and Poulterers, the restorers and hotels are in majority (78.38%) supplied on rabbit's meat directly by the producers (Table 4). Only 8.11% of the respondents buy their merchandise outside of the wilaya.

**Table 4** - State of rabbits to the purchase

| Reasons evoked | Number of respondents | Proportion (%) |
|---|---|---|
| Breeders | 29 | 78.38 |
| Butcheries | 4 | 10.81 |
| Weekly Market | 2 | 5.41 |
| Other | 2 | 5.41 |

**Price and availability of rabbit meat**

In the Butcheries and Poulterers, the average market value of this rabbit meat is 470 ± 62 DA per kg. In the wilaya of Constantine and Algiers, the prices seem more acceptable: 360 to 380 DA per kg (Gacem and Lebas, 2000). Since the realization of this study, the prices increased considerably (700 DA) because of the increase of the prices of the raw materials on the world market and that constitute the feed of the rabbits.


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Chicken usually costs less than DA 300 per kg. This is not exclusive to Algeria. Dalle Zotte (2002) argues that in developed countries the production costs for rabbits are twice as high as for chicken broilers. This implies that rabbit meat consequently becomes more expensive than other white meats and thus its consumption is automatically decreased especially at level of low-income families which are the most numerous in the Tizi-Ouzou area.

However, the most frequent problem is the lack of rabbit meat in the Butcheries and Poulterers, so urban citizens, liking rabbit meat can buy it only in few stores at the level of the urban center of the city of Tizi-Ouzou, often far from several kilometres of the dwelling place. The main problem in rational raising of rabbits in Algeria is that commercial feeds are very expensive. This is, in part, because many of their main ingredients as soybean meal, dehydrated alfalfa, corn and other micro ingredients, are imported from overseas. Dehydrated alfalfa and soybean meal often comprise 30 to 40% and 10 to 20%, respectively of the feed ration for rabbits.

In addition to higher cost of production, due to the lack of access to important inputs and services, smallholders tend to have lower productivity. According to Zerrouki et al. (2005a), the numerical productivity recorded in this region is about 25 to 30 rabbits weaned/female/year. For the same population and in the experimental farm, Zerrouki et al. (2005b) got slightly better performances but confirms the limits of this genotype.

Lack of technical know-how is the other reason which decreases the productivity. Many rabbit's raisers do not control the techniques of raising especially the reproduction. The majority of breeders have limited education, which limits their capacity to adopt new methods.

### Relation between type of store and independent variables

Source of approvisionning, education level of customers and quantities of rabbit meat sold per week are not related to the type of store (Table 5). Whereas, was observed the difference ($P<0.05$) between the type of establishment and the fidelity of the customers. These are the poulterers and butchers who receive the same rabbit meat purchasers.

**Table 5** - Relation between the type of store and the independent variables

| Criteria | Signification |
|---|---|
| Type of store / Source of approvisionning | ns |
| Type of store / faithful or varied customers | * |
| Type of store / Education level of customers | ns |
| Type of store / quantities of rabbit meat sold per week | ns |

* P<0.05; ns: non significant

Globally, 10.51±5.9 kg of rabbit meat is sold per store per week, whereas the total quantities sold is 44.56 kg per week (Table 6) or an average of 32 carcasses per/week. Per type of store, butchers are the ones who sold the great quantities, this although they are not numerous (only 3).

**Table 6** - Quantities of rabbit meat sold per week

| Type of store | Quantities sold (kg/week) |
|---|---|
| Butcheries | 13.66 |
| Poulterers | 11.3 |
| Restaurants | 9.8 |
| Hotels | 9.8 |
| Total | 44.56 |

## CONCLUSION

The study indicates that there already exists a small market for rabbit in the wilaya of Tizi-Ouzou. Based on the analysis presented earlier, it appears that there are significant deficiencies in this marketing system. It is fragmented, inefficient so the distribution chain of this meat is disorganized. This inefficient marketing system has resulted in higher costs and low availability of rabbit meat, but with a possibility for expansion through appropriate promotion. Despite those problems, there are also opportunities for expansion of this market. Given the current low levels of consumption of rabbit meat, there is potential for total consumption of this meat to increase substantially as production and availability increases.

The ultimate objective is to educate the public about the high nutritional quality of rabbit meat. Also, in this region the Rabbit seem to be the meat of the restaurant as encountered in some Mediterranean countries like Malta, Italy or Spain.


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# NUTRIENT UTILIZATION IN BUFFALO BULLS FED CROP RESIDUE BASED RATIONS

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**ABSTRACT:** *In 4 x 4 LSD, four graded Murrah buffalo bulls (6 yrs; 353 ± 8.26 kg) were fed four iso-nitrogenous complete rations comprising of jowar stover (CR1), maize stover (CR2), red gram straw (CR3) and black gram straw (CR4) as roughage source and concentrate mixture in 60:40 proportion, to study the effect of feeding complete rations on nutrient utilization. The DM intake (kg/d) was similar in all the groups. The digestibility coefficients of DM, OM, CP, EE, CF, NDF, ADF, Cellulose and Hemi-cellulose were significantly (P<0.01) higher in buffalo bulls fed CR2 while NFE digestibility was higher (P<0.05) in CR3 when compared to those fed other complete rations. All the animals were in positive N, Ca and P balances. Further, the % DCP and % TDN were significantly higher (P<0.01) in buffalo bulls fed CR2. It could be concluded that maize stover compared to other crop residues could be a superior roughage source for inclusion in complete rations for feeding buffalo bulls.*

**Key words:** *Black Gram Straw, Buffalo Bulls, Complete Rations, Jowar Stover, Maize Stover, Nutrient Utilization, Red Gram Straw*.

ORIGINAL ARTICLE

## INTRODUCTION

India posses huge livestock population comprising of 279 million bovines which produced 112.11 million tonnes of milk (FAO, 2009). This huge livestock population needs special attention of nutritionists for supplying sufficient nutrients not only to fulfill their hunger but also to maintain the optimum productivity potentials (Waje et al., 2010). In India, the area under fodder production has remained static at around 4% of the total cultivable land area for the last three decades (NIANP Feed Disc, 2005). There is little hope to increase the cultivated area under green forages or to regenerate the degraded pastures through intensive management. This necessitates efficient utilization of crop residues for ruminant feeding. In developing countries including India, the production of crop residues has steadily increased during the last four decades, as a spill-over effect of 'Green Revolution'. These crop residues have special importance in livestock feeding as they constitute a major portion of roughages. High percentage of structural carbohydrate and low nitrogen content of these roughages result in low palatability and poor nutrient utilization in ruminants. However, incorporation of these crop residues in complete diets improves both palatability and nutrient utilization (Dhuria et al., 2011). The complete feed system not only ensures better utilization of nutrients from agricultural crop residues but also supplies balanced nutrients, controls the ratio of roughage to concentrate, provide uniform blend of feed, reduces feed wastage and enables use of locally available feed ingredients (Raut et al., 2002; Krishnamurthy and Ramaprasad, 2005). Hence, an attempt has been made to study the effect of feeding complete rations containing different locally available crop residues on nutrient utilization in buffalo bulls.

## MATERIALS AND METHODS

In 4 x 4 LSD, four graded Murrah buffalo bulls (6 yrs; 353 ± 8.26 kg) were used to study the effect of feeding complete rations containing different crop residues on nutrient utilization. The animals were housed in well ventilated conventional stall barn and fed respective diets throughout the experimental period. Four iso-nitrogenous complete rations (Roughage concentrate ratio 60:40) were formulated using locally available crop residues *viz.* jowar stover (CR1), maize stover (CR2), red gram straw (CR3) and black gram straw (CR4) as roughage component. All the bulls were offered 6.5 kg each of respective complete ration to meet the nutrient requirements as per ICAR (1998). The ingredient composition of these complete rations is furnished in Table 1.

Each period of LSD consisted of a 21 day preliminary period followed by a 7 day collection period. Representative samples of complete feeds, faeces and urine were collected and analyzed for proximate principles



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(AOAC, 2007) and fibre fractions (Van Soest et al., 1991). The estimation of calcium and phosphorus in feed and faeces was done as per Talapatra et al. (1940) and in urine samples was done according to the methods described by Ferro and Ham (1957) and Fiske and Subba Row (1925), respectively.

Statistical analysis of the data was carried out as per the procedures suggested (Snedecor and Cochran, 1994) using SPSS version 17.0.

**Table 1 -** Ingredient composition of complete rations fed to graded Murrah buffalo bulls during the metabolism trial

| Ingredient | Complete rations | | | |
|---|---|---|---|---|
| | CR1 | CR2 | CR3 | CR4 |
| Jowar stover | 60 | – | – | – |
| Maize stover | – | 60 | – | – |
| Red gram straw | – | – | 60 | – |
| Black gram straw | – | – | – | 60 |
| Maize grain | 6.0 | 7.2 | 8.0 | 9.6 |
| DORB | 7.7 | 8.1 | 10.5 | 12.5 |
| Cotton seed cake | 15.6 | 12.4 | 11.6 | 8.8 |
| Gingelly cake | 9.2 | 10.8 | 8.4 | 7.6 |
| Mineral mixture | 1.0 | 1.0 | 1.0 | 1.0 |
| Salt | 0.5 | 0.5 | 0.5 | 0.5 |
| Total | 100 | 100 | 100 | 100 |

## RESULTS AND DISCUSSION

The chemical composition of crop residues and crop residue based complete rations fed to buffalo bulls during metabolism trial were presented in Table 2. The daily dry matter intake (DMI) calculated in terms of kg/100kg BW or as g/kg $W^{0.75}$ was similar among buffalo bulls fed complete rations containing different crop residues (Table 3) which may be attributed to the uniformity in particle size (8 mm mesh size) of feed ingredients included in the complete rations. Further, the DMI recorded in all the groups was higher than the requirement as suggested by ICAR (1998). This indicates that the diets were palatable and that incorporation of locally available crop residues as roughage source has not affected the palatability of complete rations. Similar findings were also reported by Rajmane and Deshmukh (2000) in goats, Jadhav and Deshmukh (2001) in sheep and Suresha et al. (2009) in goats.

**Table 2 -** Chemical composition (%DMB) of crop residues and complete rations

| Nutrient | Jowar stover | Maize stover | Red gram straw | Black gram straw | CR1 | CR2 | CR3 | CR4 |
|---|---|---|---|---|---|---|---|---|
| Dry matter | 91.45 | 92.08 | 93.56 | 91.67 | 92.72 | 92.87 | 93.18 | 92.60 |
| Organic matter | 92.19 | 92.69 | 97.65 | 92.2 | 90.84 | 91.08 | 94.05 | 90.85 |
| Total ash | 7.81 | 7.31 | 2.35 | 7.8 | 9.16 | 8.92 | 5.95 | 9.15 |
| Crude protein | 3.78 | 4.68 | 5.7 | 7.29 | 13.53 | 13.54 | 13.73 | 13.13 |
| Ether extract | 1.76 | 1.96 | 1.51 | 7.23 | 1.73 | 1.37 | 1.33 | 1.14 |
| Crude fibre | 41.44 | 39.34 | 59.95 | 54.03 | 33.90 | 33.71 | 45.18 | 39.56 |
| Nitrogen free extract | 45.21 | 46.71 | 30.49 | 29.66 | 41.68 | 42.46 | 33.81 | 37.02 |
| Neutral detergent fibre | 74.36 | 76.12 | 81.98 | 72.56 | 63.9 | 68.6 | 71.13 | 65.29 |
| Acid detergent fibre | 58.65 | 56.38 | 72.51 | 66.69 | 44.19 | 42.36 | 50.44 | 47.82 |
| Acid detergent lignin | 10.12 | 8.3 | 15.78 | 13.36 | 8.32 | 6.50 | 12.08 | 10.16 |
| Hemicellulose | 15.71 | 19.74 | 9.47 | 5.87 | 19.71 | 26.24 | 20.69 | 17.47 |
| Cellulose | 46.9 | 47.58 | 58.2 | 54.6 | 32.29 | 32.12 | 37.19 | 34.5 |
| Silica | 2.59 | 1.8 | 0.66 | 0.26 | 3.3 | 3.58 | 2.30 | 2.49 |

The digestibility co-efficients (Table 3) of DM, OM, CP, EE and CF were higher ($P<0.01$) in buffalo bulls fed CR2. These results corroborated with findings of Nageswara Rao et al. (1995) who reported higher digestibility in native bucks fed maize stover based complete ration among different crop residue based complete rations. Similarly, Raja Kishore (2012) also reported increased digestibility of nutrients in buffalo bulls fed maize stover based complete rations compared to either red gram straw or black gram straw based complete ration. The digestibility co-efficients (Table 3) of NDF, ADF, hemicellulose and cellulose were higher ($P<0.01$) in CR2 which might be due to lower lignin content of the ration. Similar observations were reported by Nageswara Rao et al. (1995) in native bucks. Further, results revealed that the digestibilities of nutrients in other crop residue based complete rations are also within the normal range. These results support the hypothesis that complete feeds provide uniform supply of nutrients at regular interval which helps to maintain steady rumen environment resulting in better digestibility of nutrients (Talpada et al., 2002). Similar to these observations higher digestibility in complete rations were observed by Reddy et al. (2001) in buffalo bulls, Mahender et al. (2006) in Nellore lambs and Kumar et al. (2010) in lactating Murrah buffaloes. The DCP content expressed as % in the diet consumed was higher ($P<0.01$) in buffalo bulls fed CR2 when compared to those fed CR1, CR3 and CR4. The higher DCP content in


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buffalo bulls fed CR2 might be due to its higher CP digestibility. Similarly, TDN content expressed as % in the diet consumed was higher (P<0.01) in buffalo bulls fed CR2 as compared to those fed other complete rations which may be a reflection of increased nutrient digestibilities in buffalo bulls fed CR2 when compared to others.

**Table 3 -** Nutrient utilization and nutritive value of complete rations

| Particulars | CR1 | CR2 | CR3 | CR4 |
|---|---|---|---|---|
| **Dry matter intake** | | | | |
| Kg / 100 kg BW | 1.74 | 1.70 | 1.67 | 1.68 |
| g / kg $W^{0.75}$ | 75.12 | 75.12 | 75.90 | 75.30 |
| **Nutrient digestibility (%)** | | | | |
| Dry matter** | $52.98^{b} \pm 0356$ | $58.37^{c} \pm 0.87$ | $55.30^{b} \pm 1.19$ | $48.41^{a} \pm 0.88$ |
| Organic matter** | $55.44^{a} \pm 0.28$ | $61.47^{c} \pm 0.41$ | $57.73^{b} \pm 0.83$ | $53.85^{a} \pm 0.53$ |
| Crude protein** | $67.80^{b} \pm 0.69$ | $70.68^{c} \pm 0.55$ | $66.39^{b} \pm 0.80$ | $64.12^{a} \pm 0.65$ |
| Ether extract** | $55.22^{c} \pm 0.36$ | $56.62^{c} \pm 0.65$ | $51.24^{b} \pm 0.68$ | $46.96^{a} \pm 0.74$ |
| Crude fibre** | $44.85^{a} \pm 0.51$ | $54.94^{c} \pm 0.68$ | $48.48^{b} \pm 0.87$ | $43.99^{a} \pm 0.67$ |
| Nitrogen free extract* | $59.95^{a} \pm 1.14$ | $63.94^{ab} \pm 1.20$ | $66.88^{b} \pm 2.39$ | $61.53^{a} \pm 0.95$ |
| Neutral detergent fibre** | $44.26^{b} \pm 0.31$ | $56.31^{d} \pm 0.63$ | $47.07^{c} \pm 0.90$ | $41.84^{a} \pm 0.70$ |
| Acid detergent fibre** | $36.76^{ab} \pm 0.40$ | $44.77^{c} \pm 0.93$ | $37.69^{b} \pm 1.26$ | $34.53^{a} \pm 0.79$ |
| Hemi cellulose** | $61.67^{a} \pm 0.69$ | $75.15^{c} \pm 0.64$ | $69.93^{b} \pm 0.65$ | $61.84^{a} \pm 0.90$ |
| Cellulose** | $48.13^{a} \pm 0.80$ | $61.45^{b} \pm 0.22$ | $46.35^{a} \pm 1.39$ | $48.16^{a} \pm 1.03$ |
| **Nutrient intake (g /kg $W^{0.75}$)** | | | | |
| DCP intake | 6.89 ± 0.14 | 7.19 ± 0.20 | 6.96 ± 0.31 | 6.33 ± 0.12 |
| TDN intake* | $38.71^{ab} \pm 1.17$ | $42.92^{c} \pm 1.55$ | $41.89^{bc} \pm 1.40$ | $37.49^{a} \pm 0.71$ |
| **Nutritive value** | | | | |
| DCP (%)** | $9.17^{b} \pm 0.09$ | $9.57^{c} \pm 0.07$ | $9.16^{b} \pm 0.11$ | $8.41^{a} \pm 0.09$ |
| TDN (%)** | $51.52^{b} \pm 0.26$ | $57.10^{d} \pm 0.39$ | $55.20^{c} \pm 0.78$ | $49.80^{a} \pm 0.48$ |

$^{abcd}$ values in the rows bearing different superscripts differ significantly. *P<0.05; **P<0.01

**Table 4 -** Effect of feeding complete rations on intake and balance (g / d) of N, Ca and P in buffalo bulls

| Particulars | CR1 | CR2 | CR3 | CR4 |
|---|---|---|---|---|
| **Nitrogen, g/d** | | | | |
| Intake | 130.47 | 130.77 | 131.45 | 129.46 |
| N outgo, g/d | | | | |
| In Faeces | 63.72 | 64.66 | 63.08 | 63.56 |
| In Urine** | $15.89^{a}$ | $14.79^{a}$ | $17.23^{b}$ | $14.89^{a}$ |
| Total | 79.61 | 79.45 | 80.30 | 78.44 |
| N balance | | | | |
| g/d | 50.86 | 51.31 | 51.14 | 51.01 |
| Percent of intake | 38.98 | 39.24 | 38.91 | 39.40 |
| Percent of absorbed** | $76.19^{b}$ | $77.63^{c}$ | $74.81^{a}$ | $77.42^{bc}$ |
| **Calcium, g/d** | | | | |
| Intake | 54.21 | 55.23 | 54.95 | 55.54 |
| Ca outgo, g/d | | | | |
| In faeces * | $35.93^{a}$ | $37.17^{ab}$ | $37.92^{b}$ | $36.39^{a}$ |
| In Urine** | $3.90^{a}$ | $3.77^{a}$ | $4.47^{b}$ | $5.28^{c}$ |
| Total** | $39.83^{a}$ | $40.94^{ab}$ | $42.39^{b}$ | $41.67^{b}$ |
| Ca balance | | | | |
| g/d* | $14.38^{b}$ | $14.29^{b}$ | $12.56^{a}$ | $13.88^{ab}$ |
| Percent of intake* | $26.53^{b}$ | $25.87^{b}$ | $22.85^{a}$ | $24.99^{ab}$ |
| Percent of absorbed** | $78.65^{b}$ | $79.12^{b}$ | $73.67^{a}$ | $72.40^{a}$ |
| **Phosphorus, g/d** | | | | |
| Intake | 28.90 | 29.63 | 29.37 | 28.65 |
| P outgo, g/d | | | | |
| In faeces | 11.12 | 11.82 | 11.81 | 11.40 |
| In Urine** | $5.80^{a}$ | $6.19^{ab}$ | $6.70^{bc}$ | $7.04^{c}$ |
| Total | 16.92 | 18.00 | 17.56 | 17.25 |
| P balance | | | | |
| g/day | 11.97 | 11.63 | 11.81 | 11.40 |
| Percent of intake | 41.43 | 39.25 | 40.20 | 39.78 |
| Percent of absorbed** | $67.33^{c}$ | $65.25^{bc}$ | $63.80^{ab}$ | $61.78^{a}$ |

$^{abcd}$ values in the rows bearing different superscripts differ significantly. *P<0.05, **P<0.01.

All the buffalo bulls were in positive balance for nitrogen, calcium and phosphorus (Table 4) indicating that the complete rations fed to buffalo bulls met the requirements. Further, this might be due to better utilization of these minerals due to uniform supply of required nutrients by complete feeds. Positive N, Ca and P balances were reported by Rekhate et al. (2008) in goats, Pandya et al. (2009) in crossbred calves and Suresha et al. (2009) in


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goats fed complete ration. The nitrogen retention expressed as % absorbed was higher (P<0.01) in CR2 compared to CR1 and CR3 while, no significant difference was observed among CR2 and CR4. These results corroborated with the findings of Raja Kishore (2012) who reported higher (P<0.01) N retention in maize stover based complete ration compared to either red gram straw or black gram straw based complete rations. High N retention observed in buffalo bulls fed CR2 might be due to better digestibility of nutrients leading to optimal utilization of dietary N by rumen microbes (Reddy et al., 2002) or poor quality of nitrogen in other crop residues (Sihag et al., 2008). The calcium retention expressed as % absorbed was higher (P<0.01) in CR2 compared to CR3 and CR4 while, no significant difference was observed between CR1 and CR2. Similar observation was reported by Raja Kishore (2012) in buffalo bulls. However, the phosphorus retention expressed as % absorbed was higher (P<0.01) in CR1 compared to CR3 and CR4 while, no significant difference was observed between CR1 and CR2.

## CONCLUSION

It is concluded that maize stover was superior roughage source among the locally available crop residues considered for inclusion in complete rations of buffalo bulls.

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# FEATURES TOPOGRAPHY AND MACROSTRUCTURE OF LYMPH NODES IN CAMELS (*Camelus dromedarius*)

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**ABSTRACT:** *This study was conducted to investigate the special features of topography and macrostructure of some somatic and visceral lymph nodes of the dromedary (Camelus dromedarius). The result of the study demonstrated that the arrangement and the morphometric characteristics of some lymph nodes of camel correspond to the analogical indices of cattle. At the organ level, the lymph nodes of camel congregate; they are partially fused. A pattern of spatial orientation of these nodes is not established. Lymph nodes of dromedary (Camelus dromedarius) according to their topography and linear characteristics in general correspond to the similar nodes of cattle. The architecture of the lymph node dromedary (Camelus dromedarius) differs from that shown in the conventional patterns of other mammalian animals, generally formed of a plurality of aggregates, the latter are surrounded by a connective tissue which extends over the whole area surface lymph node and each cluster is a node itself. Vascular distribution in these lymphoid aggregates is relatively abundant and each node receives one or two afferent lymphatic's and is drained by four or five efferent lymphatic's. In approximately half of nodes examined, there was extra nodal communic-ations between the lymphatic vessels (afferent and efferent), allowing to bypass the lymph node. Lymph nodes are characterized by their dromedary lobule appearance and size.*

**Key words:** *Lymph Nodes, Dromedary, Topography, Macrostructure.*

ORIGINAL ARTICLE

## INTRODUCTION

Single-humped Camel (Camelus of dromedarius), is one of the basic forms of productive mammals in the countries of North Africa and Near East (Yagil et al., 1994). The adaptation of this species of animals to the extreme desert living environment contributed to the appearance of a whole series of structural-functional special features in the life-supporting systems of organism (Zine Filali and Shaw, 2004; Kamoun et al., 1989). In many works, they are noted the high adaptive properties of the organs of the immune system of camel, which is manifested, above all, by significant resistance to a variety of infections and infestations (Kayouli et al., 1995). In the literature to the present day, they are encountered the contradictions, which are concerned the special features of the structural-functional organization of the blood and immune protection of camel. In this case one of the basic contradictions is the assertion about the uniqueness of the structure of the lymph nodes, in parenchyma of which lack a clear zonation, typical of all other mammal species which demonstrated by AbdelMagied et al., 2001). There is no single point of opinion about the special main intra site features in the lymph nodes of the camel (Soliman and Mazher, 2005; Taher et al., 1979). For the explanation of all existing contradictions conducting a comprehensive study of the lymph nodes of camel at the different levels of structural organization from the organ to the sub cellular is necessary. This work is dedicated to a study of the special features of topograph y and macrostructure of the basic somatic and visceral lymph nodes of dromedary (Camelus of dromedarius)

## MATERIALS AND METHODS

Work is executed in the laboratory of histology, immunology-cytology chemistry and pathology-morphology of the scientific research bio-safety center and ecological control of resources, with the department of the general and pathologic anatomy of agricultural animals of Dnepropetrovsk DNAY. We have Investigated the somatic lymph nodes (parotid, sub-mandibular, superficial cervical, axillary, popliteal) and visceral (medial retropharyngeal, caudal mediastinal, portal, jejunal, medial iliac) lymph nodes (Ln) of mature dromedaries (Camelus dromedarius). The selection of material was produced on healthy animals, in the slaughter house of Ouargla city, Algeria. They were Determined the topographic and the macroscopic characteristics, the morphometric parameters indices of lymph nodes. Length and the width of organs were measured with the aid of the rule with accuracy to 0,01 cm. The



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absolute mass of organs was determined with the aid of the analytical balance KERN-440-35A. Numerical data were processed with the use of a standard program packet "statist SF".

## RESULTS AND DISCUSSION

The results of our studies demonstrate the lymph nodes congregate, formed as a result of the partial union of smaller units, which gives to units' characteristic lobulation (Figure 1). In our studies we did not reveal any specific regularity in the arrangement of the separate nodes (small units) within the limits of the congregate. The forming congregate units grow together predominantly by their sides. In this case in each lymph node unit, we can see thickenings of capsule, oriented in different directions, and clearly are distinguished.

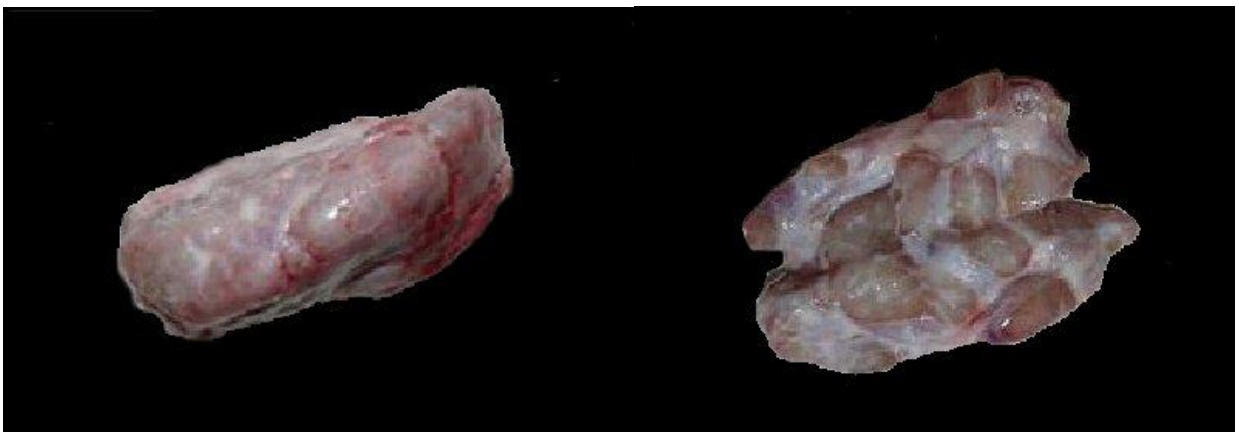

Figure1. Sub mandibular lymph node of mature dromedary (Camelus dromedarius): Common form (tuberosity of surface); View of section (lobulation).

Among the somatic units studied, Smaller sizes among the somatic lymph nodes relative have superficial cervical and sub-mandibular nodes. Superficial cervical lymph nodes are constant, oval- elongated form. These lymph nodes are located cranioventrally, from the humeral joint, covered with brachio-cephalic and brachio-atlantum muscles (Table1).

Table 1 - Absolute and relative mass of some somatic and visceral lymph nodes in mature camel (M±m)

| Somatical Lymph nodes | N° | Absolute mass, g | Mass ratio, % |
|---|---|---|---|
| Parotid | 12 | 4,20±0,30 | 0,011±0,006 |
| Sub-mandibular | 8 | 8,47±0,51 | 0,021±0,001 |
| The superficial cervical | 13 | 8,66±0,31 | 0,020±0,001 |
| Axillary | 6 | 5,53±0,43 | 0,015±0,001 |
| Popliteal | 11 | 6,43±0,31 | 0,016±0,001 |
| **Visceral Lymph nodes** | **N°** | **Absolute mass, g** | **Mass ratio, %** |
| The medial retropharyngeal | 12 | 10,02±0,26 | 0,025±0,001 |
| Caudal mediastinal | 11 | 20,45±1,70 | 0,052±0,003 |
| Portal | 8 | 8,15±0,24 | 0,020±0,001 |
| Jejunal | 7 | 4,99±0,46 | 0,013±0,001 |
| The medial iliac | 8 | 7,15±0,50 | 0,018±0,001 |

Outside the units of congregates, covered with capsule consist of dense fibrous connective tissue, and the space between their separate units (lobules) filled with friable cellulose tissue (friable unformulated connective tissue), that gives to the lymph nodes of camel the similarity to the grooved multi-papillary kidney of the mammals or the salivary gland. In general, the lymph nodes of camel have sufficiently dense consistency (dense texture), and their lobulation isperceived even through the skin during the palpation.

Sub-mandibular lymph nodes are sharply lobed (Figure 1). They are Located in the corner of the lower jaw on its medial surface. Dorsally it borders on the mandibular salivary gland, and ventrally with the sublingual and facial veins (Figure 1). The absolute mass of superficial cervical lymph node is: 8,66±0,31 g, sub mandibular: 8,47±0,51 g, mass ratio 0,020±0,001% and 0,021±0,001% respectively. The superficial cervical lymph nodes length reaches7,83±0,34 cm, sub-mandibular: 6,88±0,61 cm, the width 4,71±0,27 cm and 4,53±0,27 cm respectively (Figure 2).


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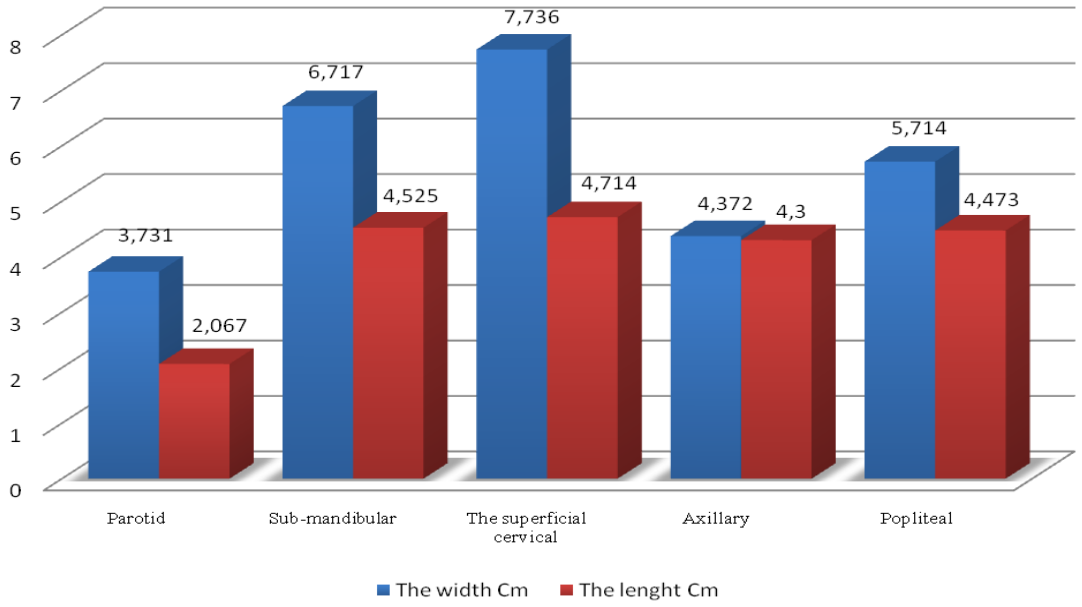


**Figure 2. Morphometric indices of some somatical lymph nodes nodes of the camel**

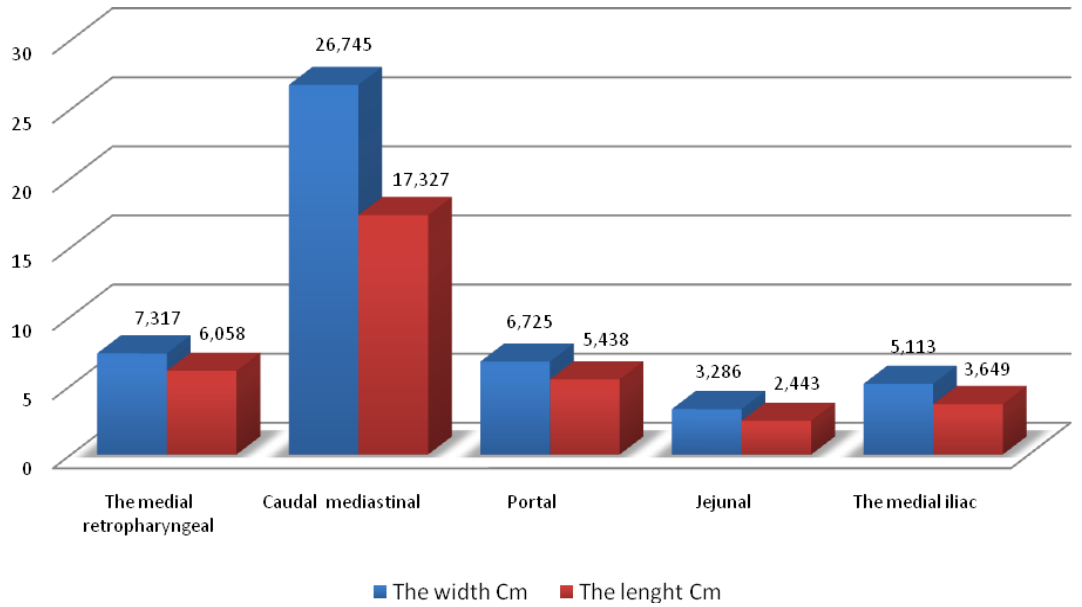


**Figure 3. Morphometric indices of some visceral lymph nodes of camel (camelus dromedaries)**

Parotid lymph node has the smallest morphometric indices among the somatic nodes of the camel. Its absolute mass reaches 4, 20±0,30 g, with mass ratio - 0,011±0,006%. The length is 3, 53±0, 21 cm, but width does not exceed 2, 07±0, 26 cm. Among the camel visceral lymph nodes studied, the maximum size being investigated has the caudal mediastinal lymph node. Its sizes and morphometric characteristics more than twice exceeding the analogous indices of the largest somatic lymph nodes (see tables).

Caudal mediastinal lymph node large, unpaired, has a form of the curved triangle. It is located in the caudal mediastinal on the latero-dorsal surface of oesophagus and the ventral surface of the thoracic aorta. Caudally it reaches the tenth thoracic vertebra, but due to the significant size of some animals may it can be up to the first lumbar vertebra. The absolute mass of caudal mediastinal lymph nodes, reaches 20,45±1,70 g, with mass ratio - 0,052±0,003%. Average length reaches 26,75±1,58 cm, width exceed 17, 33±1,26 cm (Figure 3).

The largest of lymph nodes in camel appears medial retropharyngeal. It's the paired, lobule, divided into two parts. It will be Stir in the cranial section of neck, along the sides of the lower part of the pharynx. The dorsal surface of lymph nodes is divided by the groove, in which passes the carotid artery. The medial retropharyngeal lymph nodes absolute weighs: 10, 02±0,26 g with relative weight 0,025±0,001%.

The morphometric indices vary between 7,32±0,29 cm in length and 6,06±0,28 cm in width. Average values of mass and linear measurements are characteristic of lymph nodes of organs and walls of abdominal cavity


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(hepatic and medial iliac nodes). The hepatic lymph nodes, which can be inconstant, the extra hepatic and the additional lymph nodes are located in the site of attachment to the small gland in the groove, around the portal vein; it is partially hidden in the pancreas.

The medial iliac lymph node of the camel consists of two assemblies (large and small). This relatively large, with the bumpy surface, they lie on the small lumbar muscle at the corner formed by external and internal iliac arteries. Left medial iliac lymph node sometimes merges with the sacral lymph node. The absolute mass of the hepatic of lymph nodes reach 8,15±0,24 g and of the medial iliac: 7,15±0,50 g, which composes 0,020±0,001 and 0,018±0,001% respectively from the mass of the body of animal. The length of the hepatic of lymph nodes reaches 6,73±0,16 cm, and the medial iliac of 5,11±0,32 cm, the width vary respectively 5,44±0,08 and 3,65±0,28 cm.

The jejunum lymph nodes are most numerous among the nodes of the abdominal cavity of camels. These groups are circular or oval lymph nodes, which are located along the attachment of the mesentery to the small intestine. Absolute mass of largest jejunum lymph nodes reach 4, 99±0,46 g, which corresponds to 0,013±0,001% of the mass of the body of camel. Length does not exceed 3, 29±0,29 cm, but the width of 2,44±0,21 cm. The results of our study obtained, suggest that the topography of the investigated lymph nodes of dromedary (Camelus dromedarius), generally corresponds to the same in cattle (Анатомія свійських тварин, 2001; Цюнская et al., 1965). Some differences touch the medial retropharyngeal lymph nodes. These nodes are connected with the head and the neck in this species of mammals. As a result, the lymph nodes are not located on the dorsal wall of the pharynx, as in other mammals, but on its latero-ventral surface in the cranial division of the cervical region.

Some special features touch the typical arrangement of the popliteal lymph nodes of camel, in comparison with similar lymph node in cattle; they are displaced distally and are located on the caudal surface of the tendon of gastrocnemius muscle. Caudal mediastinal lymph node in camel is much more developed than that of cattle. This node is clearly delimited from middle mediastinal of lymph nodes. Macroscopically, the structure of the lymph nodes of camel largely similar degree analogous to the nodes in horses, the findings of this study are in agreement with the one shown in Анатомія свійських тварин (2001). Unlike horses in which small units within particular central nodes are absolutely isolated independent organs, in camel, they grow into different degree together between themselves forming congregate of lymph node; In this case, in spite the fusion of the individual sections of parenchyma of nodes, their gates remain in the majority of the cases isolated. This result is in agreement with Taher et al. (1979) and Soliman and Mazher (2005).

Some author indicates the similarity of the macroscopic structure of the lymph nodes of camel with the relevant domestic pigs, these lymph nodes are also formed as a result the consolidations of separate small units. However, it should be noted that the degree of fusion of nodes in a single organ of pig is more expressed, in consequence of which they greater resemble to tuberous conglomerations, than congregate, which is characteristic for the lymph nodes of camel (Тішкіна, 2007; Гаврилин et al., 2007).

We also know that because of the special arrangement of the efferent lymph nodes and lymph movement in pigs occurs in the "opposite" direction from the portal sinus to the boundary (Тішкіна, 2007). The data about the nature of the dynamic of lymph in the nodes of the camel are contradictory. Information about the fact that the bearing and efferent lymphatic vessels in the lymph nodes of camel were found in one and the same section of their capsule, on the convex surface of nodes, will not be coordinated with the current ideas brought by Taher (1963) and Soliman and Mazher (2005). About the principles of the circulation of lymph in the organism of mammals and require conducting the additional studies.

The linear characteristics of the lymph nodes of camel (Camelus dromedarius) mostly vary in the same limits, as the lymph nodes of cattle with an appropriate body weight, the result agree with Гаврилін (2000). According to the data of Шура И.В, some visceral lymph nodes of camel (caudal mediastinal, medial iliac) are developed to greater extent, which is probably caused by the higher degree of the functional activity of unites under the conditions of the living environment of characteristic for the dromedaries.

## CONCLUSIONS

The lymph nodes of dromedary (Camelus dromedarius) according to their topography and linear characteristics in general correspond to the similar nodes of cattle and macroscopic structure- they occupy the intermediate position between the corresponding lymphatic organs of horse and pig. Macroscopically, the lymph nodes of camel congregate; they are partially fused, structural-functional units (small units) without evidence of the specific attitude.

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# HEAMATOLOGICAL AND SERUM BIOCHEMICAL CHARACTERISTICS OF COCKERELS FED GRADED LEVELS OF BOILED SORREL SEED MEAL

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**ABSTRACT:** *The effect of feeding graded levels of boiled sorrel seed meal (BSSM) at 0,15,30,45 and 60% as replacement for groundnut cake in the diet of 200 seven day old chicks of Isa brown x Goldline cockerel on heamatological and serum biochemical indices was assessed in a 14week feeding trial. Each treatment consisted of forty birds and was replicated four times with 10 birds per replicate in a completely randomized design. At the end of the experiment, blood samples were randomly collected from four birds in each group for heamatological and blood chemistry studies. BSSM at 60% significantly (P<0.05) increased the values of RBC, Hb, WBC, PCV and MCV although they were within normal ranges. Total protein and albumin were significantly (P<0.05) increased while creatinine was significantly (P<0.05) reduced by higher levels of BSSM in the diet. It was concluded that up to 60% of GNC can be replaced by BSSM in the diet of cockerels without adverse effects on blood characteristics.*

ORIGINAL ARTICLE

**Keywords:** *Cockerels, Boiled Sorrel Seed Meal, Heamatology, Serum Biochemistry*

## INTRODUCTION

The use of groundnut cake and soya bean meal as the only source of protein in poultry diet is generally becoming economically impracticable in Nigeria. Due to soaring price of these conventional feed ingredients (Ubosi, 1986) in developing countries, commercial poultry enterprises are closing down. So the development of cheap and readily available alternative sources of feed ingredient in poultry nutrition is currently receiving attention. One of such non-conventional feed ingredient that can be used as an alternative to groundnut cake, soya bean cake and fish meal is the sorrel seed meal (*Hibsicuss sabdariffa).* It is less competed for by both human and livestock and hence not expensive. The leaves are used as vegetable by humans and the stem produces fibre while the seeds on the other hand are widely eaten by scavenging poultry (Philips, 1977).

In avian species, hematobiochemical studies are almost always performed for research purposes in order to evaluate the effect of rearing technique, feeding regimes, environmental condition and toxicity levels (Vergal *et al.,* 1984; Duwa et al., 2012; Kabir, 2012). Swenson (1993) reported that the erythrocyte indices are used to measure the size and haemoglobin content of erythrocytes and values are useful in diagnosing diseases, toxicity level and aneamia. Awoniyi et al. (2000) also reported that haemoglobin and haematocrits values are influenced by temperature. The PCV which measures the cellular concentration of RBC in relation to the plasma volume is usually the first indicator of aneamia. This study was designed to determine the effect of boiled sorrel seed meal as replacement for groundnut cake on blood parameters of broilers under a semi-arid condition.

## MATERIALS AND METHODS

### Experimental Site

The study was conducted at the Poultry Production Unit (PPU) of Borno State Ministry of Agriculture and Natural Resources Maiduguri. The farm had standard deep litter houses. The study area lies between Latitude $11^0$ – $51^1$N and longitude $013^0$ - $05^1$E and had an altitude of 354m above sea level. It is characterized by hot and dry climate and short duration of erratic rainfall (3 – 4) months per annum and a long period of dry season. Ambient temperatures are low in December to January ranging from 15 – 19°C and high in March to June, ranging from 33 – 44°C and low relative humidity ranging from 5 – 43.5% (Alaku, 1983).



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**Experimental Stock and Diet**

Two hundred 7 days-old Isa brown x Goldline cockerel chicks were used for the study. The cockerel chicks were individually weighed and randomly selected and allocated to each of the five replacement levels of groundnut cake replaced by boiled sorrel seed meal (BSSM) in a completely randomized design. Each treatment consisted of forty birds and was replicated four times with 10 birds per replicate. The sorrel seed meal was incorporated at 0, 15, 30, 45 and 60% level of replacement for groundnut cake respectively as shown in the Tables 1 and 2. The sorrel seeds used in this study were procured locally around Maiduguri and processed as follows; 25kg of sorrel seeds were cleaned and boiled in water for 30 minutes at 100$^{o}$C in an aluminum pot, sun-dried for three days, then milled and incorporated into the diets of cockerels.

Each treatment received one of the diets. Feed and clean drinking water were provided *ad libitum* throughout the experimental period of 14 weeks.

**Table 1 -** Composition of chick mash containing varying levels of boiled sorrel seed meal

| Ingredients (%) | Replacement levels of groundnut cake by boiled sorrel seed meal | | | | |
|---|---|---|---|---|---|
| | (Control 0%) | 15% | 30% | 45% | 60% |
| Maize | 57.47 | 56.97 | 55.97 | 54.97 | 53.97 |
| Groundnut cake | 20.28 | 17.24 | 14.20 | 11.15 | 8.11 |
| Sorrel seed meal | 0.00 | 3.04 | 6.08 | 9.13 | 12.17 |
| Wheat offals | 13.00 | 13.00 | 13.00 | 13.00 | 13.00 |
| Fish meal | 5.50 | 6.00 | 7.00 | 8.00 | 9.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Methionine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix [1] | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| TOTAL | 100 | 100 | 100 | 100 | 100 |
| **Calculated analysis** | | | | | |
| Crude protein (%) | 19.93 | 19.91 | 19.88 | 19.67 | 19.56 |
| ME (kcal/kg) | 2807.24 | 2802.70 | 2795.70 | 2788.10 | 2780.0 |
| Crude fibre (%) | 3.84 | 4.14 | 4.45 | 4.75 | 5.06 |
| Calcium (%) | 1.08 | 1.01 | 1.06 | 1.12 | 1.17 |
| Phosphorus (%) | 1.01 | 1.07 | 1.15 | 1.13 | 1.14 |
| Lysine (%) | 0.87 | 0.99 | 1.15 | 1.29 | 1.44 |
| Methionine (%) | 0.32 | 0.36 | 0.41 | 0.45 | 0.49 |

[1] Bio-mix chicks supplied /kg Vit. A = 4,000,000.00 IU, Vit. $D_3$ = 800,000.00 IU Vit. E = 9,200.00mg, Niacin = 11,000.00mg Vit $B_1$= 720.00mg, $B_2$ = 2,000.00mg $B_6$ = 1,200.00mg, 1200.00mg $B_{12}$ = 600mg; $K_3$ = 800.00mg, Pantothenic acid = 3,000.00mg; Biotin = 2,400.00mg, Folic acid = 300.00mg; Iodine 400.00mg; Iron = 8,000.00mg, manganese = 16, 000.00mg; selenium = 80.00mg; zinc = 12,000.00mg; Anti oxidant = 500.00mg.

**Table 2 -** Composition of growers mash diet containing varying levels of boiled sorrel seed meal

| Ingredients (%) | Replacement levels of groundnut cake by boiled sorrel seed meal | | | | |
|---|---|---|---|---|---|
| | (Control 0%) | 15% | 30% | 45% | 60% |
| Maize | 67.37 | 66.87 | 66.37 | 65.87 | 65.37 |
| Groundnut cake | 9.88 | 8.40 | 6.92 | 5.43 | 3.95 |
| Sorrel seed meal | 0.00 | 1.48 | 2.96 | 4.45 | 5.93 |
| Wheat offal | 16.00 | 16.00 | 16.00 | 16.00 | 16.00 |
| Fish meal | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Methionine | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix * | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| TOTAL | 100 | 100 | 100 | 100 | 100 |
| **Calculated analysis** | | | | | |
| Crude protein (%) | 15.00 | 14.90 | 14.90 | 14.93 | 14.80 |
| ME (kcal/kg) | 2849.52 | 2845.90 | 2845.90 | 2838.64 | 2835.01 |
| Crude fibre (%) | 3.85 | 3.99 | 4.15 | 4.29 | 4.44 |
| Calcium (%) | 1.30 | 1.37 | 1.50 | 1.48 | 1.46 |
| Phosphorus (%) | 1.03 | 1.04 | 1.11 | 1.12 | 1.13 |
| Lysine (%) | 0.61 | 0.67 | 0.75 | 0.82 | 0.89 |
| Methionine (%) | 0.25 | 0.28 | 0.3 | 0.32 | 0.35 |

* Bio-mix Grower supplied /kg, Vit. A =4,000,000.00 IU, Vit. $D_3$ = 800,000.00 IU, Vit. E = 10,000.00mg, $K_1$ = 200.00mg, $B_2$ = 1000.00mg; Pantothenic acid = 3,500.00mg, Biotin = 1,500.00mg, Folic Acid = 200,000mg, Choline Chloride = 120,000.00mg, cobalt = 80.00mg; copper = 800.00mg, Iodine = 100.00mg, Iron = 15,000.00mg; Manganese = 60,000.00mg Selenium = 400.00mg; Zinc =15,000.00mg, Anti oxidant = 400.00mg.



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### Blood Collection and Analysis

At the end of the experiment, blood samples were randomly collected from four birds in each group for heamatological and blood chemistry studies. Each blood sample were taken from the wing-vein by means of a sterile disposable (21-guage) syringe and needle, and then into sample bottles containing dipotassium salts of ethylene diamine tetra-acetic acid (EDTA) for heamatological studies while samples for biochemical indices were collected into anticoagulant free tubes and allowed to clot. Sera were obtained after the blood sample has been allowed to stand for two hours at room temperature and centrifuged for ten minutes at 2000 rpm to separate the plasma from the serum.

Microhaematocrit method was used to determine packed cell volume (PCV) and cyanmethaemoglobin method was used to determine haemoglobin (Hb). Red blood cell (RBC) and white blood cell (WBC) counts were determined using Neubauer haemocytometer. Mean corpuscular volume (MCV), Mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) were calculated according to the standard formula of Schalm et al. (1985). Total protein was determined, using the burette method and urea was by the dimethethyl monoxide method. Creatinine was determined by Jaffe reaction method while serum albumin was obtained using the dye–binding technique with bromocresol green. Serum potassium, Calcium and sodium were determined by the calorimetric method (Daumas, 1975; Varley et al., 1980; Henry et al., 1974; WHO, 2003).

### Statistical analysis

Data were analyzed as a completely randomized design using the General Linear Model (GLM) procedure of the Statistical Analysis Software package (SAS Institute, 2002), means were compared using the least significant difference (LSD).

## RESULTS AND DISCUSSION

The heamatological indices of cockerels fed different levels of boiled sorrel seed meal (BSSM) are shown in Table 3. A significant difference (P<0.05) was observed for all the parameters measured. Mean corpuscular heamoglobin values were depressed (P<0.05) by BSSM at levels above 15%. MCHC was significantly lowered (P<0.05) at 60% levels of replacement.

**Table 3 -** Blood parameters of cockerels fed on diets containing varying levels of sorrel seed meal as a replacement for groundnut cake

| Parameters | Replacement levels of GNC by BSSM | | | | | |
|---|---|---|---|---|---|---|
| | (0%) | 15% | 30% | 45% | 60% | ±SEM |
| RBC x $10^6$/ dl | $3.45^{d}$ | $4.60^{c}$ | $4.40^{c}$ | $7.32^{b}$ | $9.51^{a}$ | 0.165* |
| WBC x $10^3$/$mm^3$ | $14.00^{c}$ | $17.75^{b}$ | $17.25^{b}$ | $18.25^{ab}$ | $21.50^{a}$ | 1.071* |
| Hb (%) | $15.25^{d}$ | $16.20^{cd}$ | $18.45^{ab}$ | $17.47^{bc}$ | $19.40^{a}$ | 0.434* |
| MCHC (g/l) | $33.52^{b}$ | $33.30^{b}$ | $35.25^{ab}$ | $33.27^{b}$ | $25.48^{c}$ | 0.484* |
| MCH (µg) | $28.67^{a}$ | $27.88^{a}$ | $24.65^{b}$ | $24.20^{b}$ | $25.28^{b}$ | 0.558* |
| MCV (ft) | $126.75^{c}$ | $141.90^{ab}$ | $141.75^{ab}$ | $136.65^{b}$ | $144.85^{a}$ | 1.703* |
| PCV (%) | $26.50^{b}$ | $26.00^{b}$ | $26.00^{b}$ | $27.50^{a}$ | $28.50^{a}$ | 0.418* |

$^{a, b, c, d}$ Means within the same row bearing different superscripts differ significantly (P<0.05), SEM – Standard Error of Means, NS – Not significant (P>0.05), * Significant difference (P<0.05)

**Table 4 -** Blood parameters of cockerels fed on diets containing varying levels of sorrel seed meal as a replacement for groundnut cake

| PARAMETERS | Replacement levels of GNC by BSSM | | | | | |
|---|---|---|---|---|---|---|
| | 0% | 15% | 30% | 45% | 60% | ± SEM |
| Protein (g/dl) | $4.22^{c}$ | $4.98^{b}$ | $5.11^{b}$ | $6.88^{a}$ | $6.82^{a}$ | 0.472* |
| Albumin (g/dl) | $2.96^{c}$ | $3.78^{b}$ | $4.41^{a}$ | $3.87^{ab}$ | $3.98^{ab}$ | 1.881* |
| Globulin (g/dl) | 1.24 | 1.07 | 1.01 | 2.99 | 2.92 | $0.121^{NS}$ |
| Glucose (Mmol/L) | $9.33^{b}$ | $8.68^{b}$ | $9.85^{b}$ | $9.94^{b}$ | $12.14^{a}$ | 0.148* |
| Cholesterol (mg/dl) | 3.33 | 3.12 | 2.98 | 3.04 | 2.82 | $0.220^{NS}$ |
| Urea (mg/dl) | $4.56^{a}$ | $3.11^{ab}$ | $2.19^{c}$ | $3.36^{ab}$ | $3.29^{ab}$ | 1.061* |
| Creatinine (Mmol/L) | $47.37^{ab}$ | $44.88^{b}$ | $50.02^{a}$ | $41.18^{c}$ | $40.11^{c}$ | 6.014* |
| Sodium (Mmol/L) | $142.11^{a}$ | $140.10^{a}$ | $135.19^{b}$ | $134.34^{b}$ | $140.56^{c}$ | 11.180* |
| Potassium (Mmol/L) | $4.19^{a}$ | $2.67^{c}$ | $3.81^{ab}$ | $5.73^{a}$ | $3.08^{ab}$ | 1.011* |
| Calcium (Mmol/L) | $1.37^{c}$ | $2.48^{a}$ | $1.97^{b}$ | $1.88^{b}$ | $2.77^{a}$ | 0.107* |
| Bicarbonate (Mmol/L) | 18.2 | 17.31 | 19.07 | 19.58 | 19.11 | $1.010^{NS}$ |
| Total Bilirubin (mg/dl) | $4.12^{c}$ | $6.10^{a}$ | $4.80^{c}$ | $5.71^{b}$ | $7.18^{a}$ | 1.013* |
| Conjugated Bilirubin (mg/dl) | $5.14^{b}$ | $3.26^{c}$ | $5.01^{b}$ | $6.44^{a}$ | $5.19^{b}$ | 1.870* |
| Alkaline Phosphatase (IU/L) | 40.47 | 41.39 | 39.79 | 40.19 | 40.73 | $1.347^{NS}$ |
| AST (IU/L) | 11.31 | 9.18 | 10.89 | 11.01 | 11.89 | $2.531^{NS}$ |
| ALT (IU/L) | 10.78 | 10.96 | 8.91 | 9.1 | 10.11 | $1.499^{NS}$ |

$^{a, b, c, d}$ Means within the same row bearing different superscripts differ significantly (P<0.05), SEM – Standard Error of Means, NS – Not significant (P>0.05), * Significant difference (P<0.05)



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All other parameters measured were however higher (P<0.05) in the group fed the highest replacement levels compared to the control. The values obtained for all the heamatological indices were similar to ranges reported by Kwari et al. (2010) and Duwa et al. (2012) when cockerels were fed dietary sorrel seed meal. Similarly, the values are within the ranges reported by CCAC (1980) and Merck (1986) for normal chicken. This shows that BSSM had no adverse effect on erythropoiesis and is an indication that the diet did not cause nutrient restriction.

Results of the biochemical indices for cockerels fed BSSM are shown on Table 4. No effect (P>0.05) of dietary BSSM was seen on the following parameters; globulin, cholesterol, bicarbonate, Alkaline phosphatase, ALT (Alkaline Amino Transferase) and AST (Aspartate Amino Transferase) which is an indication that BSSM has no toxic effect. This is contrary to the report of Kwari et al. (2010) who fed differently processed sorrel seed meal. The results however showed that total protein value rose with increased levels of dietary BSSM, although a statistical difference (P<0.05) was observed for values of albumin no specific trend was noticed. Urea levels were similar (P>0.05) between the control and other treatments except the group offered 30% replacement which had lower values. Creatinine was however, depressed (P<0.05) by higher levels (45 – 60%) of BSSM compared to the control. It has been reported by Butani et al. (2002) that dietary protein affects serum creatinine by elevating it values. Hence, the difference observed in this work may be as a result of the higher protein in GNC compared to BSSM and not an impairment of renal function. Glucose level was highest (P<0.05) in the group with 60% replacement level. Levels of Sodium ($Na^+$), Potassium ($K^+$) and Calcium ($Ca^{2+}$) all differ among treatments. Sodium at the highest level of replacement (60%) was similar (P>0.05) to the control group. Potassium was depressed at 15% level of inclusion of BSSM but it was similar for all other groups. Generally, calcium levels were higher in the groups fed BSSM. This may be attributed to the higher calcium levels in sorrel seeds compared to groundnut cake (Kwari et al., 2011).

It has been reported that heamatological and serum biochemical indices are affected by nutritional status of an individual (Adeyemo et al., 2010; Kwari et al., 2011; Obikaonu et al., 2011)

## CONCLUSION

It was concluded that up to 60% of dietary groundnut cake can be replaced with BSSM without adverse effects on heamatology and serum biochemical parameters of cockerels.

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# THE NUTRITIONAL COMPOSITION AND ACCEPTABILITY OF CACTI (*Opuntia ficus indica*)-LEGUME MIXED SILAGE

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**ABSTRACT:** *The potential of making silage using dry browse legume hay (Acacia angustissima, Leucaena leucocephala, Calliandra callothrysus and Macroptilium Atropurpureum) mixed with fresh cactus (Opuntia ficus-indica) for winter supplementation of veld grass was evaluated using the proximate, tannins and the pH analyses. Chemical analysis revealed that N values were significantly increased (P<0.05). The N levels were 3.72, 4.5, 4.05, and 2.5% DM for A. angustissima, L. leucocephala, C. callothrysus and M. atropurpureum respectively, which were higher when compared to silage made from cereals. The NDF and ADF values were slightly higher than those reported in literature for cereal silages. The DM level of cactus –browse silage was very good (41%DM) considering that cactus normally have less than 10% DM. The silage pH was within the reported range, ranging from 3.97 to 4.11 on a pH meter. This was a good indicator of silage quality considering that low pH inhibit undesirable microbial activities. The tannins levels were lower in the silages but significantly different (P<0.05) between browse legume species. Ensiling lowered the tannin levels in the silage compared to the individual browse legume tannin levels. This study concluded that purely on compositional laboratory analysis, the legumes and cactus can be used to make silage which can be used by farmers during dry season.*

ORIGINAL ARTICLE

**Key words:** *Opuntia ficus indica, Silage, Browse Legumes, Tannins, pH, Nitrogen*

## INTRODUCTION

Livestock play a very crucial role in poverty alleviation, food and nutritional security for the country (Gambiza, et al., 2000; Ngongoni et al., 2006, 2009; Odongo et al, 2010). However, fluctuations in both quality and quantity of feed make the sector unreliable and susceptible to high livestock mortality and low productivity (Vasta et al, 2008; Ngongoni et al, 2009). Therefore, there is need to conserve forage as silage for utilization in times of deficits, especially in dry season. The materials for making silage have been limited to cereals which lead to direct competition with humans. Utilization of cactus, which is readily available (Nefzauoi et al., 2010), and included in the list of invasive or weed species (Tibe et al., 2008) could be a solution in maximizing available feed for winter supplementation. However, cacti have low dry matter content and very low CP ( Batista et al., 2003; Gebnemariam et al., 2006) making it very difficult to make silage (De Kock, 2001; Meiteka, 2008). Browse legumes are a good source of nitrogen (Mupagwa et al., 2003; Ngongoni et al., 2007) but with varied degree of digestibility due tannins (Nefzauoi et al., 2002; Ben Salem et al., 2004, 2005; Makkar, 2003). Mixing cacti with high soluble carbohydrates and browse hay with high nitrogen to improve dry matter and CP level in silage could be a way to provide high quality feed available for the dry season (Curek et al., 2009). The objective of this study was to determine the quality of silage produced when cacti and browse hay are mixed and ensiled as well as to evaluate the acceptability of this silage by ruminant animals.

## MATERIALS AND METHODS

### Study site

The experiment was conducted at Makoholi Research Station, 32 km North of Masvingo Town on 19$^0$50' S and 30$^0$47'E. Rainfall is unreliable both within and between seasons (mean annual 565mm and range from 133 - 1155mm). The altitude averages 1200m above mean sea level. The Station lies in agro-ecological region IV. Its soils are granite derived with typical arable topsoil, which consists of sand 96%, silt 2% and clay 2%. Soils are



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inherently infertile and plant growth and ranch cow fertility are severely limited by the unavailability of nitrogen and phosphorus.

### Sample preparations

Four browse legume trees biomass were harvested separately between January and March. The harvested biomass were air dried under shade for five days to approximately 88% dry matter (DM) before being separately stored in a dry place with proper ventilation. Each browse hay was then mixed with fresh cut cactus *(Opuntia ficus indica*) before ensiling. The native species of cactus was used and the spines were removed using fire before maceration. The silage was made using 60 % fresh cactus and 40 % browse hay and ensiled in polythene bags on a weight/weight basis. Two percent molasses was added in the mixture to enhance fermentation. Ten bags of each containing twenty kilograms of treatment were made as replicates. The silage was incubated for 42 days in a rodents free room. After 42 days of incubation a sample was taken from each treatment bag for analysis. The samples were analysed for pH and oven dried. The samples were ground through a 3mm screen, using a Wiley hammer mill and analysed for chemical composition and silage quality. The other treatment bags were used in palatability feeding trial using goats, beef and dairy cattle at Makoholi research Station.

### Chemical composition analysis

The *Opuntia ficus-indica*-legume silage was analysed for dry matter (DM), organic matter (OM), Nitrogen (N), (AOAC, 2000). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to the procedure of Goering and Van Soest (1970). Total ash was obtained by igniting a dried sample in a muffle furnace at 600$^{o}$C for 24 hours and calcium and phosphorous was determined by the EDTA method and spectrophotometer method, respectively. The total condensed tannins (TCT) in the silage was analysed using the Butanol-HCl method by Swain and Hillis (1959) and modified by Porter et al. (1986). Silage pH was determined using a pH meter.

### Palatability studies with Mashona cows

Sixteen lactating beef cows were used to evaluate acceptability of the silages made out of cactus and browse legume hay. In a complete randomized block design, twelve cows were assigned into four treatment diets. Each animal was given 3 kgs of silage per day in the morning before they were taken to the paddocks for grazing. The amount eaten was measured and refuse was also measured. The study was carried for ten days. The data was then analysed.

### Dairy crossbreed trial

Sixteen dairy cows were randomly assigned to four treatment diets. The cows were offered 3 kgs of treatment diet per day after milking. The amount eaten that was and that was left out, was measured. The trial lasted for 10 days and the data was analysed. The animals were allowed graze after the treatment diet was offered.

### Goats trial

Sixteen lactating Small East African goats were used to assess the acceptability of the silage made out of cactus and browse legume hay. In completely randomized design twelve goats were assigned to four treatment diets with four replicates per treatment. The goats were offered 500 grams of the treatment diet per day. The feed eaten was measured so as the refusals.

### Statistical analysis

Analysis of variance on the chemical composition of the silage was carried out using the GLM procedure of SAS (SAS, 2000). Contrasts were carried out to examine the effect of browse type on N, ADF TCT and pH of the silage quality. Comparison of treatment means was done using the Tukeys method.

The following model was used:

$Y_{ijk} = \mu + V_i + \varepsilon_{ijk}$

Where;

$Y_{ijk}$ = Response variable being DM, CP, ADF, NDF, Ca, P and TCT of each cactus-legume silage

$\mu$ = Overall mean common to all observations;

$V_i$ = Effect of the $i^{th}$ treatment (*Leucaena leucocephala*, *A angustissima, C callothrysus*, and *Macroptilium atropurpureum);*

$\varepsilon_{ij}$ = Random residual error distributed as N (0,1 $\sigma^2_E$).

Analysis of variance was done using PROC GLM procedure of SAS (SAS, 2000) for acceptability of silage.

The following model was used;

$Y_{ijk} = \mu + V_i + \varepsilon_{ijk}$

Where;

$Y_{ijk}$ = Response variable being (Intake);

$\mu$ = Overall mean common to all observations;

$V_i$ = Effect of the $i^{th}$ treatment diet; (Cactus-Bana grass, Cactus-*Leucaena leucocephala*, Cactus-*A angustissima*, and Cactus-M atropurpureum*)*

$\varepsilon_{ij}$ = Random residual error distributed as N (0,1 $\sigma^2_E$).



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## RESULTS

### The chemical composition of the silage

Chemical analysis results for the four silages are shown in Table 1. The results showed that *Cactus-L. leucocephala* silage (CLLS) (4.51%) had higher nitrogen% (N%) than other silages, *Cactus-A. angustissima* (CAAS) (3.72%), Cactus-*C. callothrysus* (CCCS) (4.05%) and Cactus-*M. atropurpureum* silage (CMAS) (2.50%). The silages were significantly different (P<0.05) in nitrogen. The silages had no significant differences in levels of NDF, however they were significantly different in ADF so as the level of tannins. The tannins content were significantly different being highest in CCCS and lowest in CMAS. The pH levels were also significantly different with lowest pH being observed in CCLS and highest in CMAS.

**Table 1 -** The chemical composition values of the silages used in the experiment

| Composition | Silage mixture | | | | Significance | LSD | Grand mean |
|---|---|---|---|---|---|---|---|
| | CLLS | CAAS | CCCS | CMAS | | | |
| Tannins | 3.38$^{c}$ | 4.58$^{b}$ | 8.39$^{a}$ | 2.45$^{d}$ | *** | 0.57 | 4.48 |
| %DM | 37$^{a}$ | 39$^{ab}$ | 41$^{bc}$ | 43$^{c}$ | *** | 3.4 | 40 |
| %Ash | 9.19$^{a}$ | 10.61$^{a}$ | 9.62$^{a}$ | 9.32$^{a}$ | *** | 1.78 | 9.16 |
| %OM | 89.8$^{b}$ | 87.3$^{a}$ | 86.4$^{b}$ | 89.5$^{b}$ | *** | 5.7 | 88.4 |
| %N | 4.51$^{a}$ | 3.72$^{c}$ | 4.05$^{b}$ | 2.50$^{d}$ | *** | 0.2 | 2.85 |
| %NDF | 54.4$^{a}$ | 53.3$^{a}$ | 54.6$^{a}$ | 56.7$^{a}$ | *** | 2.69 | 54.7 |
| %ADF | 23.4$^{c}$ | 27.2$^{ab}$ | 24.7$^{bc}$ | 29.6$^{a}$ | *** | 1.7 | 24.4 |
| %P | 0.98$^{a}$ | 0.84$^{a}$ | 0.65$^{a}$ | 0.74$^{a}$ | *** | 0.67 | 0.06 |
| %$Ca^{2+}$ | 1.4$^{a}$ | 1.432$^{a}$ | 0.91$^{c}$ | 0.97$^{b}$ | *** | 0.07 | 0.81 |
| pH | 3.97$^{a}$ | 4.06$^{b}$ | 4.03$^{ab}$ | 4.11$^{b}$ | *** | 0.8 | 4.04 |

$^{abc}$ Means in the same row with different superscripts differ; *** - P>0.001. LSD = least significant difference; CLLS – Cactus-*Leucaena leucocephala* silage; CAAS – Cactus- *Acacia angustissima* silage ; CCCS – Cactus – *Calliandra callothrysus* silage; CMAS – Cactus – *Macroptilium atropurpureum* silage.

### Acceptability of cactus-browse silage

The results showed that dairy cows, beef cows and goats can consume cactus browse silage freely without notable challenges. There was no significant different (P < 0.05) in silages consumption by large ruminants namely Dairy crossbred cow and Mashona beef cows. However, the consumption slightly changed in small ruminants with CLLS having the highest consumption rate when compared to other silages. All the results are presented in table 2 below.

**Table 2 -** Consumption of cactus browse silage

| Diet/silage | Animal species | | |
|---|---|---|---|
| | Mashona Beef cows Kg/day | Dairy crossbred cows Kg/day | Lactating goats Grams/day |
| CLLS | 2.97$^{a}$ | 3.00$^{a}$ | 457$^{a}$ |
| CAASs | 2.95$^{a}$ | 3.00$^{a}$ | 420$^{ab}$ |
| CCCS | 2.91$^{a}$ | 2.98$^{a}$ | 397$^{b}$ |
| CMAS | 2.90$^{a}$ | 2.97$^{a}$ | 333$^{c}$ |
| Probability | P <0.05 | P <0.05 | P <0.05 |
| LSD | 0.24 | 0.11 | 0.47 |
| Grand mean | 2.94 | 2.98 | 413 |

$^{abc}$ Means in the same row with different superscripts differ

## DISCUSSION

### Silage quality

The quality of silage measured using the chemical composition was higher than the normal silage made from maize and other grass. It was also more improved silage as compared to the quality of silage obtained by Curek and Ozen (2004), which was low in CP. The total N or CP was higher (166 g/kg DM) on average than the average of 110 g/kg DM in maize silage (McDonald et al., 2002). The silage which was made using *Macroptilium atropurpureum* had the least CP (15.6 %) value but which was higher than the average for cereals silages (11.0%) (McDonald et al., 2002; Nefzaoui et al., 2010). The Calcium (Ca) and Phosphorous (P) values of legumes were higher than of cereal and this is depicted in the silage mineral value. The high Ca and P in the silage should be a positive output considering that cactus is known to have low phosphorous and the addition legumes has complementary effects. Mixing cactus with low fibre dry legume hay improved the DM content, Ca and P levels resulting in the production of well balanced silage for dairy, beef and small ruminants. Cactus have very low DM and it is difficult to make silage using it fresh or wilted (Nobel, 2001). However, in this study the silage which was made had high DM (410g/kg) which was higher than the 210g/kg DM reported by McDonald et al. (2002) for


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maize as the average. The silage was higher in ADF (21-27 %) compared to maize silage of less than 22 % and this is explained by the fact that the silage was made from browse hay which was totally dry before ensiling. The process of ensiling done using cactus and browse hay improved the DM for cactus which is normally too low to make silage.

It was observed that the TCT was lower in silage than in the individual browse species reported by Makkar (2003), Mupangwa et al. (2003) and Ngongoni et al. (2007). The values reported by D'melo et al. (1995) were higher than the findings in this study. This could be attributed to the explanation by Makkar (2003) that storage, drying, chemical treatment and solid state fermentation can be used in detanninification of feedstuffs. The levels of tannins should have been lowered by the biochemical process that took place during the fermentation activities in the silo. He reported that a decrease in the value of total phenol, condensed tannins and protein precipitation capacity by 55, 77 and 65% at day 1, 72 and 89 of ensiling respectively. Higher temperatures were reported to have an effect on the protein precipitation of tannin and the total condensed tannins. During the ensiling process temperature rises above 37°C, which was reported by Makkar (2003) to have a detanninifiction effect. There are a number of chemical and biochemical reactions that took place in silo bags that affect the pH and thus causing a reduction in total condensed tannins. Makkar (2003) also reported that 40 % ethanol removed about 70 % of the tannins in oak leaves; the findings are supported by the finding in this study.

### Silage pH as an indicator of Quality

Silage pH was ranging from 4.0 to 4.23. The values were lower than pH 4.8 which was referred as good silage indictor in *(*Mugweni et al., 2000; McDonald et al., 2002; Curek and Ozen, 2004). The lower the pH the high the soluble sugars in the silage ingredients. The cactus has high soluble sugars (Ben Salem and Abidi, 2009) that were fermented and adequately reduce the pH to the range that can preserve the silage. Also the addition of molasses at 2% w/w could have the contribution effect on lowering the pH to the acceptable levels. McDonald et al. (2002) reported that legumes are more buffered than grass and are consequently more difficult to ensile satisfactorily. This was not the case in this study and could be attributed to high soluble sugar cactus and the addition of molasses which ferment and the acid produced increased the hydrogen ion concentration to a level at which the undesirable bacteria are inhibited.

### Acceptability of the silage to livestock

All the categories of livestock used in the study consumed the silage without any notable challenges. There was no problem of laxative effects due to high water content in cactus as the dry mater level was improved with the addition of browse and forage hay. The crude protein level was also improved through the addition of browse hay. These diets could be safely be used as supplements due to their high levels of crude protein. In the small ruminants trial, goats on cactus-*M. Atropurpureum* consumed slightly less than other cactus-browse silage. This could be attributed to the higher levels of ADF than other species in the trial (Mupangwa et al., 2003). Considering that the smallholder and communal farmers in Zimbabwe experiences eight month feed deficit period, the use of cactus and browse should go a long way in livestock production and poverty alleviation. Dairying in small holder farming communities have challenges of quality feed leading to low milk yield and high cow mortality (Ngongoni et al., 2006; Mupangwa et al., 2003). The silages can be used to improve milk production especially in drier areas of Zimbabwe where cactus is a common green plant during the dry season.

## CONCLUSIONS

The study showed that browse legumes and cactus can make good quality silage. Although the quality can be compromised by the amount of tannins, it was observed that ensiling reduced the amount of tannins. Finally the silage has the potential to bridge the perennial feed deficit gap experienced in subtropical and tropical Africa from April to November. Utilization of these feed resources will improve ruminant livestock productivity especially in drought prone areas of the region.

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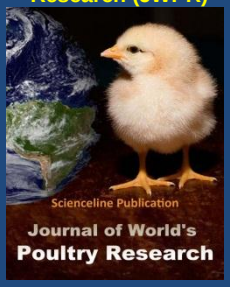
|   |   |   |   |
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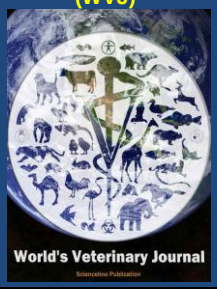
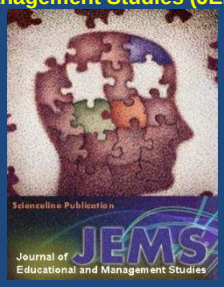
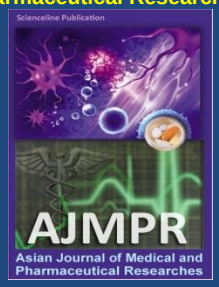
|   |   |   |   |
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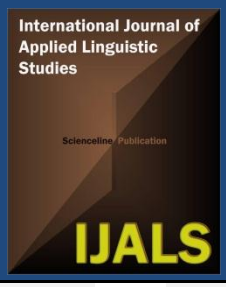
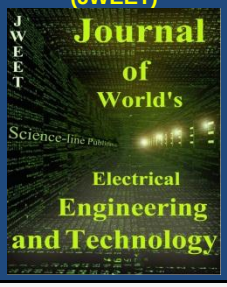
|   |   | | |

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