EFFECT OF FEEDING SORGHUM HUSK TREATED WITH DIFFERENT LEVELS OF UREA ON NUTRIENT DIGESTIBILITY, SOME BLOOD METABOLITES AND GROWTH PERFORMANCE OF GROWING SAIDI MALE LAMBS

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SUMMARY

This study aims to evaluate the effects of using sorghum husk treated with different levels of urea on the feed intake, digestibility, and blood parameters of growing Saidi male lambs. Twenty-one Saidi male lambs, with an average age of 5.5 months and a body weight of 26.75 ± 2.29 kg, were randomly assigned into three treatments in a completely randomized design. The groups consisted of three diets: a control diet, sorghum husk + 2.5% urea, and sorghum husk + 5% urea. The feeding trial lasted for 120 days. Results non-significant increases in DM intake (P>0.05), significant linear increase in TDN, SV, SE and CP (P<0.05) as the level of urea increased. The same trend was observed with digestibility (P<0.05) of DM, OM, CP, CF, EE and NFE. As The level of urea increased (0,2.5 and 5%) ruminal pH, NH3-N, total nitrogen and VFA's were significantly (P<0.05) increased. Blood serum total protein, albumin, globulin, glucose, GPT, creatinine and urea were linearly increased (P<0.0) as the level of urea in the diet was increased. Final body weight, total weight gain, ADG and FCR were significantly(P<0.05) improved as the level of urea in the diet was increased.

Keywords: *Sorghum husk, nutrient digestibility, growing Saidi male lambs, blood constituents, feed intake, and performance growth.*

INTRODUCTION

Cereal crop residues and by-products play a crucial role in the feeding of ruminant livestock in tropical countries, including Egypt, as they make up a significant portion of the ruminant's diets. However, these crop residues are low in nitrogen, minerals, vitamins, and digestibility, making them poor in nutritive value. Despite that, with suitable chemical processing and incorporation into a complete diet in mash or pellet form, these crop residues can contribute to the optimum growth of ruminant livestock (Reddy *et al.*, 2003).

Researchers worldwide have studied the effects of chemical treatments on agricultural residue by-products, including Belewu (1998) and Belewu and Okhawere (1998). In Egypt sorghum is a significant summer grain crop, following rice and maize in importance. Egypt leads the world in sorghum production per unit area, with the majority of cultivation taking place in Upper Egypt. Annually, about 400 thousand feddans are dedicated to sorghum cultivation, with about 80% of this area located in the governorates of Fayoum, Assiut, and Sohag. In 2000, the total cultivated area reached 376 thousand feddans, with an average productivity of 2.450 Ton / feddan, resulting in a total production of 924 thousand Ton FAOSTAT (2000-2019). Sorghum husk is often disposed of by being thrown into a manure pit or used as fuel or bedding for livestock. In times of famine or scarcity, it may even be fed to the animals.

However, the nutritional value of sorghum by-products, such as sorghum husk (SH), was found to be low due to the presence of anti-nutritional factors like phytic acid, polyphenols, and tannins. As a result, SH was considered to be a low-protein and low-energy roughage feed for cattle, sheep, and goats (Gaur and Taparia 1991).

Moreover, Gaboush(2010) found that up to 40% concentrate could be replaced by urea-treated SH in fattening sheep along with a reduction in production cost, whereas, the average daily gain was non-significantly decreased. Hamed (2015) concluded that SH had low nutritive value, but it was palatable and could be used as a basal diet ingredient for ruminants. However, till now there is little information on the

possibility, palatability and efficiency of SH served as feed ingredient. Therefore, the aim of the current study was to examine the impact of chemical treatments (such as urea) on nutrient composition, nutrients digestibility, ruminal parameters, blood serum metabolites and growth performance of Saidi lambs.

MATERIALS AND METHODS

***Ethical approval*:**

All experimental procedures (animal care, sampling) were conducted in accordance with the standards established by Faculty of Research Ethics Committee at Faculty of Agriculture, Ain Shams University. Animal experimentation in the study was approved by Faculty of Agriculture Research Broad (Approved A 4-2023-02).

Site:

The experiment was conducted in Wadi El Nokra, Aswan, Egypt.

Preparation of diets:

Sorghum husk was obtained from the EL-Amal Fields village after the crop harvesting. The by-product was not previously used in animal rations and was typically used as bedding material for livestock. The treatment diets of the experiment were as illustrated in Table (1) as following:

1- T1 (Basal diet 0% Urea)
2- T2 (Basal diet +2.5% Urea)
3- T3 (Basal diet +5% Urea)

The solutions were prepared by dissolving five g of urea in 40 ml of water. The treated sorghum husk was kept in air tight a bags and assigned randomly to storage at 30°C for 2 weeks.

Animals, housing, and management:

Twenty-one growing Saidi male lambs, with an average age of 5.5 months and initial average body weights of 25.27, 25.05, and 25.20 for T1, T2, and T3 respectively, were randomly distributed in three equal groups (7 animals each). The groups were fed on T1, T2 and T3, respectively. The Saidi-growing male lambs were initially weighed, identified, dewormed, and vaccinated against clostridium disease. The animals were housed in well-ventilated pens with a concrete surface. All the animals were vaccinated for external and internal parasites with ivermectin and fenbendazole drugs, respectively. The experimental groups were offered their respective experimental rations ad libitum. Measured quantities of experimental rations were offered three times daily at 07:00, 14:00, and 20:00 hrs., and any residues left were weighed after 24 hrs., with daily adjustments made to allow for 10% orts. Clean water was available all day. The animals were weighed every 30 days before being offered feed and water in the morning (fasted) to adjust the rations. Average daily gain (ADG), feed conversion ratio, and feed cost of weight gain were calculated.

Digestibility trail:

Five animals were used for the digestibility trails at the end of experimental period. The digestibility trails consisted of 7days as primary period followed by collection period of 7 days. Each animal was weighed at the first day of the primary period and the last day of the collection period. Faeces were collected daily every 24 hrs in plastic bags and weighed. A 5% of the total daily faeces of each animal was taken as a sample and sprayed with solution of 10% formaldehyde and 10% H_2SO_4 and dried in the oven at 65°C for 24 hrs.

Dried samples of the collection period were mixed and composite samples were kept for analysis (10% of the total quantity). Feed residues (if any) were removed and weighed for each animal every morning for feed consumption. The samples of diets, faeces and feed residues were analyses for crude protein, ether extract, crude fiber and ash according to the AOAC (2003), methods. NFE was calculated by difference.

Sampling of rumen liquor:

On the last day of the digestibility trial, rumen fermentation characteristics were determined at zero time before the morning feeding. Rumen liquor (100 mL) was sampled by stomach tube and strained through 4 layers of cheesecloth. The pH of ruminal fluid was immediately determined using a digital pH meter and a mercury thermometer, respectively. Strained rumen liquor was stored in 45 mL glass bottles, with adding a few drops of toluene and paraffin oil just to cover the surface, and stored at -20º C for analysis of total nitrogen (TN), and NH3-N were analyzed as described by AOAC (2003). Total volatile fatty acid (TVFA) was determined according to Warner (1964).

Blood sampling and analysis:

At the end of the feeding trial (four months) and before the morning feeding blood samples were taken from the jugular vein of five animals in the experiment. The samples were directly collected into a vacuum tube and centrifuged at 2500 rpm for 15 min. Serum was separated then translated into polypropylene tube and stored at -20^{o} C until analysis for total proteins (g/dl) and albumin (g/dl), respectively. Serum globulin (g/dl) was calculated by the difference between total protein and corresponding value of albumin. Glucose, urea (mg/dl), creatinine (mg/dl), alanine amino transaminase (ALT) , aspartate transaminase (AST) and cholesterol (mg/dl) were determined according to the methods described by AOAC (2003).

Statistical analysis:

The data obtained from the experiment were analyzed using analysis of variance (ANOVA) with a completely randomized single-factor design. Means between treatments were compared using the least significant difference (LSD). The statistical procedures were computed using SAS (2002).

RESULTS AND DISCUSSION

Effects different levels of urea on chemical composition of sorghum husk:

Table (1) showed the crude protein, dry matter, crude fiber and ether extract for conventional diets and urea treated sorghum husk diets. The dry matter content of the experimental diets varied between (84.55% to 88.97%). Sorghum husk treated with a 5% urea diet recorded the highest CP content ((15.9%) while the lowest value was recorded for untreated sorghum husk (9.04%). The crude protein value increased from T1 (9.04%) to T3 (15.9%) which means that crude protein content increased as the level of urea increased in the diet.

The increase in crude protein content of treated SH could be attributed to the urea process. These results were supported by Tesfaye (2006), Ali *et al.* (2012), and Egbu (2014), who reported an increase in crude protein content of various crop residues as a result of urea supplementation. Atta Elmnan *et al.* (2015) reported that the increment of CP for sugar cane bagasse may be due to enhanced nitrogen content, induced by the addition of nitrogenous substrate. This result is similar to that of Atta Elmnan *et al.* (2007), who showed that urea and ammonia treatments increased CP content for sugar cane bagasse (SCB). Similar results were obtained by Ambaye (2009), who revealed that urea treatment increased CP content of the straw from 3.35% to 7.54%, due to the binding of ammonia to the straw.

Moreover, data in Table (1) showed that the ash content was increased with sorghum husk treated with a 2.5 % urea diet, but the results were lower than those obtained by Gaboush (2010) and Aruwayo *et al.,* (2019). This increase may be due to the degradation of dry matter into ash and organic matter.

Table (1): Ingredient and chemical composition of experimental diets (on dry matter basis%).

Items	T1	T2	T3
Ingredients%			
Sorghum husk	50	50	50
Alfalfa hay	20	20	20
Corn	16	15	15
Soybean meal	10	8.5	6
Molasses	2	2	2
Urea	0	2.5	5
CaOH	1.5	1.5	1.5
NaCl	0.5	0.5	0.5
Chemical composition%			
DM	92.22	92.54	92.80
OM	91.06	90.21	90.56
CP	9.04	13.5	15.90
EE	2.57	2.24	2.21
CF	21.47	23.66	22.73
NFE	57.98	50.81	49.72
Ash	8.94	9.79	9.44

Feed intake and digestibility:

Feed intake:

Data in Table (2) showed that the feed intake as dry matter intake and dry matter/kg live body weight ($W^{0.75}$) was numerically higher with different levels of urea between the experimental rations. The increase in nitrogen content in the treated sorghum husk led to an increase in TDN and CP intake. The TDN intake in T3 was significantly higher ($P<0.05$) compared to T1 and T2 respectively. The same trend in CP intake was observed.

The present results are in agreement with those of Xu *et al.* (2019) who reported that as the NH3-N concentration in the rumen rises, microbial fermentation improves, which can lead to an increase in DM and CP intakes when urea is added. Also, Frutos *et al.* (2004) and Wahyono, *et al.* (2022) showed that adding urea to diets high in tannic tree leaves increased the amount of nitrogen that was ingested because it gave ruminal microorganisms more sources of nitrogen. Moreover, Egan and Doyle (1985) reported an increase in DM intake with urea infusion in the rumen.

Zhao *et al.* (2007) reported that that Urea is utilized by rumen microbes, which convert it to ammonia and subsequently to microbial protein, thus increasing the supply of protein available to the host

These findings contradict those of Vivian (2019), who found that a rise in urea levels in the diet had no effect on the amount of dry matter consumed (with an average of 1.175 kg of animal per day).

Table (2): Nutrient intake (g) of growing Saidi male lambs fed sorghum husk treated by different levels of urea.

Item	Experimental rations			p value
	T1	T2	T3	
Feed intake /head/day				
DMI, g	1198.79	1217.34	1277.89	0.1196
DM(g)/kg$W^{0.75}$	88.29	87.37	87.64	0.37
TDN intake, g	690.00^{b}	696.00^{b}	748.00^{a}	0.0243
SV intake, g	584.29^{b}	577.47^{c}	619.81^{a}	<.0001
CP intake, g	108.37^{c}	164.34 ^{b}	203.18^{a}	0.0254

a and b mean in the same row with different superscripts are significantly (P<0.05) different.SE=standard error.

Nutrient digestibility:

Data in Table (3) showed that the urea-treated sorghum husk diet at both levels (2.5 and 5%) increased ($P<0.05$) digestibility of dry matter, organic matter, crude protein, crude fiber, and nitrogen free extract compared to the conventional sorghum husk diet.

This outcome may have been partially attributed to alkali treatment, which converts the insoluble fraction to the soluble fraction, facilitating colonization and degradation of ingested fibrous materials by rumen cellulolytic bacteria (Atta Elmanan *et al.*, 2007).

Additionally, the stimulatory effects of nitrogen (resulting from treatment with urea) on feed intake may have contributed to the enhancement of microbial fermentation and digestion in the rumen, as well as the digestion of feed in the entire digestive tract (Egan and Doyle, 1985). The addition of urea at a level of 5% resulted in the highest DM, OM, CP, CF, and EE digestibility, which was significantly higher than that in both 2.5% and the control ration. These results are agreement with Atta Elmanan, *et al.* (2007) who found that adding 5%urea increased DM, OM, and CP digestibility.

These current results are also consistent with Mattoni *et al.* (2010), who reported that the treatment of sorghum and millet straw increased dry matter digestibility of treated vs. non-treated. Bani *et al.*, (2007) also found an inverse relationship between forage fiber fractions and DM digestibility, with nitrogen content and cell wall polysaccharides being major determinants of digestibility (Barriere *et al.*, 2003; Seven and Cerci, 2006).

Atta Elmnan *et al.* (2007, 2009) and Salman *et al.* (2011) found similar results, and suggested that the increase in digestibility of CF, CP, and DM from treated crop residues may be attributed to changes in their chemical composition, particularly with CP and CF after biological and biochemical treatments.

The improved of the nutrients digestibility with sorghum husks treated with urea may be due to increase in ruminal activity. According to Mcguire *et al.* (2013), adding urea to sheep diets with low quality fodder increased the digestibility of the entire digestive tract.

Table (3): Nutrient digestibility (g/kg DM) of growing Saidi male lambs fed sorghum husk treated with varying levels of urea.

Items,%	T1	T2	T3	SEM	P value
DM	68.29^{c}	77.52^{b}	79.82^{a}	1.37	<.0001
OM	72.64^{c}	78.14^{b}	80.61^{a}	0.91	<.0001
CP	65.87^{c}	68.42^{b}	72.16^{a}	0.72	<.0001
CF	58.67^{b}	59.61^{b}	63.60^{a}	0.73	0.0032
EE	68.01^{c}	78.24^{b}	82.33^{a}	1.64	<.0001
NFE	75.63^{c}	79.49^{c}	81.98^{a}	0.76	<.0001

a and b mean in the same row with different superscripts are significantly (P<0.05) different. SE=standard error.

Rumen parameters

Data of ruminal fermentation parameters of growing Saidi male lambs fed the experimental rations are presented in Table (4). Results revealed that rumen liquor of pH values affected significantly by the 5% level of urea in comparison with control however the 2.5% urea level did not differ with control in pH value. Odetokun (2002) showed that the variations in pH values would be generally due to the production of TVFA's. In addition, Saro *et al.* (2019) noticed that the rate of ureagenesis determines the disposal of bicarbonate and affects the maintenance of pH homeostasis.

The concentrations of ruminal NH_3-N were significantly increased with increasing urea level in ration compared with that of the control ration that may be due to the positive effects of additional urea. The level 5%urea increased NH_3-N to be (22.25 mg/L vs 18.16 mg/ L for level control). According to Aschenbachh *et al.* (2011), the rumen's NPN fermentation releases extra NH_3-N, which raises that is observed in 5% urea level, which recorded the highest values of ammonia and pH. Moreover, urea is converted by rumen bacteria into additional ruminal NH_3-N, a powerful buffer. Ruminal TVFA's and total nitrogen concentrations take the same trend with increasing urea level in ration.

Table (4): Effect of different levels of urea-treated sorghum husk on rumen parameters in growing Saidi male lambs.

Items	T1	T2	T3	P value
pH	6.26^{b}	6.21^{b}	6.37^{a}	0.0158
NH3-N(mg/100ml)	18.16^{c}	19.33^{b}	22.25^{a}	<.0001
Total nitrogen	91.20^{c}	102.93^{b}	115.02^{a}	<.0001
TVFA's (meq /100ml)	12.63^{c}	14.39^{b}	15.33^{a}	<.0001

a and b mean in the same row with different superscripts are significantly (p<0.05) different.SE=standard error.

Blood serum parameters:

Results of blood serum parameters of growing Saidi male lambs fed on the experimental rations are presented in Table (5). Data showed that the two levels of urea-treated diets had significant effects on the concentrations of blood serum total protein, albumin, globulin, GPT, creatinine, and serum urea compared to the control group. The concentration of serum total protein was increased with increasing the levels of urea in rations and these higher increases might be due to indirect response to urea ratio in ration. The same trend was observed with blood serum glucose that agree with that recorded by **Noro *et al.* (2012)**, who showed that the use of urea with different levels had a significant effect on serum glucose.

The current results are agreeing with those reported by **Vivian *et al.* (2019)** who found that the mean values for total protein, albumin, globulin and creatinine in the serum of lambs fed different levels of urea were 7.11 g dL^{-1}, 3.36 g dL^{-1}, 3.75 g dL^{-1} and 0.91 mg dL^{-1}, respectively.

Table (5): Effect of different levels of urea treatment on sorghum husk on the blood metabolites of growing Saidi male lambs.

Items	T1	T2	T3	P value
Total protein ,g/dl	6.50^{c}	6.95^{a}	7.12^{a}	<.0001
Albumin, g/dl	3.39^{b}	3.44^{b}	3.77^{a}	<.0001
Globulin, g/dl	3.12^{b}	3.51^{a}	3.35^{a}	0.004
Glucose, mg/dl	58.13^{b}	58.89^{ab}	61.47^{a}	0.036
GPT IU/L	32.99^{b}	34.61^{a}	35.50^{a}	<.0001
GOT IU/L	15.08	14.62	14.84	0.3592
Creatinine, mg/dl	0.94^{b}	1.08^{a}	1.12^{a}	0.0043
Urea, mg/dl	48.01^{c}	57.05^{b}	67.66^{a}	<.0001

a and b mean in the same row with different superscripts are significantly (P<0.05) different.

Growth performance:

Data of the Table (6) clearly indicate significantly linear improve in final body weight, total weight gain, ADG and FCR as the level of urea was increased.

These findings corroborated those of Voltolini *et al.* (2010), who reported that supplementing animals with urea increased nutritional digestibility and enhanced performance.

Data in Table (3) showed that urea supplementation improved the digestibility and nutritive value of sorghum husk. The improvement in nutritive value of sorghum husk (SH) as a result of urea treatment was further confirmed by better growth performance in terms of ADG and feed efficiency in groups treated with urea.

Table (6): Effect of sorghum husk treated with different levels of urea on the performance of growing Saidi male lambs.

Items	T1	T2	T3	P value
Initial BW.	25.27	25.05	25.20	0.4983
Final BW.	39.53^{c}	42.04^{b}	46.06^{a}	<.0001
Total weight gain	14.26^{c}	16.99^{b}	20.87^{c}	<.0001
AVDG	0.119^{c}	0.142^{b}	0.174^{a}	<.0001
Daily feed intake(g)	1198.79	1217.34	1277.89	
F C R	10.11^{a}	8.68^{b}	7.36^{c}	<.0001

a and b mean in the same row with different superscripts are significantly (P<0.05) different.

There was also an effect of different levels of urea treatment on feed conversion ratio (FCR), with the lowest value obtained by the animals consuming the diet with 0 % urea (10.11 vs 7.36) (P = 0.001), Also, the FCR values increased from 2.5%urea level and 5%urea level (8.68 and 7.36) (P < 0.05) respectively.

Economics efficiency:

Data in Table (7) showed the impact of different levels of urea treatment on sorghum husk on the economy efficiency of growing Saidi male lambs.

Cost of feed consumed was decreased significantly (P<0.001) as the level of urea increased in the rations from 62.44 LE/kg body weight gain in control group to 39.90 LE in Sorghum husks treated with5%urea diet and followed by 50.56LE in Sorghum husks treated with 2.5%urea diet.

Economic efficiency and daily feed cost /kg daily weight gain during the experimental period are shown in Table (7). The values of economic efficiency were highest in lambs fed sorghum husks treated with 5%urea (1.26) followed by lambs fed sorghum husks treated with 2.5% urea (0.78) and lambs fed sorghum husks untreated with urea (0.44).

Improve economic efficiency with sorghum husks treated with different levels of urea may be due to higher body weight gain for lambs consumed sorghum husks treated with different levels of urea compare to lambs fed sorghum husks untreated with urea.

Table (7): Effect of sorghum husk treated with different levels of urea on the Economics efficiency of growing Saidi male lambs.

Items	T1	T2	T3
Total weight gain (kg)	14.26	16.99	20.87
Total DMI (kg)/head	143.85	146.08	146.08
Feed cost (LE) for total weight gain	890.46	858.96	832.6
Cost of one kg BW(LE)	62.44	50.56	39.90
Total revenue (LE)	1283.27	1529.36	1877.91
Net revenue (LE)	392.81	670.40	1045.24
Economic efficiency	0.44	0.78	1.26
Relative economic efficiency,%	100.0	177.27	286.36

a and b mean in the same row with different superscripts are significantly ($p<0.05$) different. Base on prices of the Egyptian market during the experimental period (2021). The price of one ton of sorghum husks was 200LE/Ton, alfalfa hay was 5000 LE /Ton, corn was 12000 LE/Ton, soybean meal was 26000 LE/Ton, molasses was 25000 LE /Ton, urea was 8000 LE /Ton, CaOH was 3500 LE / Ton, NaCl was 3500 LE /Ton and live body weight was 90 L.E., respectively. Economic efficiency (%) =price of daily gain (L.E.)/daily feed cost (L.E).

CONCLUSION

Feeding sorghum husk treated with 2.5 or 5% of urea to growing Saidi male lambs improved feed intake, digestibility of DM, OM, CP, CF, and EE NFE and growth performance and economic efficiency.

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تأثير تغذية قشر الذرة الرفيعة المعامل بمستويات مختلفة من اليوريا في هضم العناصر الغذائية وبعض قياسات الدم وأداء النمو في الحملان الذكور الصعيدي

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تهدف هذه الدراسة إلى تقييم تأثير استخدام قشور الاذرة الرفيعة المعاملة بمستويات مختلفة من اليوريا على استهلاك العلف والهضم وبعض مؤشرات الدم للحملان الذكور الصعيدي النامية. تم توزيع واحد وعشرون حملاً صعيدياً، بمتوسط عمر 5, 5 أشهر ووزن جسم 26.75 ± 2.29 كجم، عشوائياً على ثلاث معاملات في تصميم عشوائي بالكامل. تكونت المجموعات من ثلاث علائق: نظام الكنترول، قشر الذرة الرفيعة المعامل 2.5% يوريا، وقشر الذرة الرفيعة المعامل 5% يوريا. استمرت تجربة التغذية لمدة 120 يومًا. أدت معاملة قشر الذرة الرفيعة بمستويات مختلفة من اليوريا في النظام الغذائي للحملان الصعيدية الذكور النامية إلى زيادة المأكول من المادة الجافة زيادة غير معنوية. واوضحت التجربة ان المعاملة ب 5% يوريا لقشور الذرة الرفيعة حسن هضم المادة الجافة والبروتين الخام والألياف الخام ومستخلص الأثير والمستخلص الخالي من النيتروجين وقد تم تسجيل فروق معنوية في معاملات هضم المادة الجافة والبروتين الخام والالياف الخام في مجموعة ال 5% يوريا وكانت اعلي المجموعات 0 كانت الزيادة النهائية في الوزن الحي مختلفة بشكل ملحوظ مع المستوي 5% يوريا تليها مجموعة ال 2.5% يوريا. وكان الاتجاه مماثلاً بالنسبة لمتوسط زيادة الوزن اليومي، حيث سجلت مجموعة المستوي 5% يوريا تلتها مجموعة المستوي 2.5% يوريا زيادة في الوزن أعلي من مجموعة المقارنة بالمجموعة المقارنة. تأثرت قياسات الدم لحيوانات التجربة معنوياً ($P<0.05$بمستوى معاملات اليوريا. لم تختلف قيم كلا من الجلوكوز وGOT في كل المجموعات التجريبية التي تم تغذيتها بمستويات مختلفة من اليوريا ($P<0.05$) بينما تركيز البروتين الكلي والألبومين وGPT والكرياتينين واليوريا تأثرت معنويا ($P<0.05$). بقشور الذرة الرفيعة المعاملة بمستويات مختلفة من اليوريا.

***الكلمات المفتاحية**: قشر الذرة الرفيعة، هضم العناصر الغذائية، نمو ذكور الحملان الصعيدية، مكونات الدم، تناول العلف ونمو الأداء.*