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EFFECT OF PARTIALLY OR COMPLETELY SUBSTITUTION OF CLOVER HAY BY GUINEA GRASS (*SPANISH PANICUM MOMBASA*) FORAGE ON NUTRIENTS DIGESTIBILITY, BLOOD PARAMETERSAND PERFORMANCE OF LACTATING BUFFALOES

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SUMMARY

This research aimed to evaluate the use of Spanish panicum mombasa (SP) as an alternative forage on the performance of lactating buffaloes exemplify digestibility, milk production and feed intake. Thirty lactating buffaloes (after 2 weeks of calving) *were distributed into five groups as folows, 1st group was fed control ration (60% concentrate feed mixture (CFM) and 40% clover hay (CH)), 2nd group was fed 60% CFM and 30% CH +10% SP (SP10), 3rd group was fed 60% CFM and 20% CH+20% SP(SP20), 4th group was fed 60% CFM and 10% CH+30% SP (SP30) and 5th group was fed 60% CFM and 40% SP (SP40). Complete replacement of CH by SP40% increased (P<0.05) nutrients digestibility coefficients. The buffaloes fed the SP40 showed higher (P<0.05) levels of plasma protein, globulin, alanine transferase (ALT), and glucose than the group fed the SP30 ration. Buffaloes fed the SP40 had higher (P<0.05) yields of all milk components and 7% fat corrected milk (FCM) than those fed other rations. When comparing diets containing SP to the control, feed efficiency showed significant changes (P≤0.05) with regard to DM, TDN, and DCP. Replacing SP in the rations decreased the cost of feed required to produce 1 kg of milk (7% FCM), especially for feed that included 40% of SP (90.36%). It could be, concluded from the results of the current study that complete replacement of CH by SP in the diets of lactating buffaloes had a positive impact on milk production, increased nutritional digestibility, and a reduction in the cost of ration.*

Keywords: Spanish panicum mombasa, nutrients digestibility, blood parameters, milk yield, lactating buffaloes

INTRODUCTION

*Panicum (*grass of Guinea), the plant belongs to the *Poaceae* family and is referred to as guinea grass in English and *panicum maximum* in science (Muir and Jank, 2004). Aganga and Tshwenyane (2004) and Pedreira *et al.*, (2015) consider it a perennial herb. Despite this, it is successfully grown in tropical and subtropical climates over the world, and its extensive root system helps it withstand severe droughts. Furthermore, *panicum* can withstand temperatures as high as 37°to 40°C. Some of its characteristics include high yields of high-quality leaves and good palatability. Meanwhile, *panicum* can grow up to three meters in height (Muir *et al.*,2001). Additionally, *panicum* can withstand high soil and water salinity and can produce up to 10 years, yielding a higher productivity than alfalfa (Hare *et al.*, 2014). *Mombasa panicum* grass has a rapid rate of production, up to 12 to 15 plants every year. It also has high nutritional content, dense foliage, and a soft texture that extends from the leaves to the roots. *Panicum mombasa* is employed as an energy source, displacing barley and other feedstuffs, in addition to having a high protein content (varying depending on the variety, 8–16%) Jank *et al (*2013). The first cut is to be made 45-90 days after planting (Hare *et al.*, 2015 and Hare *et al.*, 2013), and then a cut every 25-30 days (Garcez Neto *et al.*, 2012). Additional strategies to boost feed availability include the application of enhanced varieties, which are distinguished by high forage production, quick growth, and a high capacity for regeneration.In fact, researchers are concentrating their efforts on cultivating and refining these varieties (Akash and Saoub, 2002). Because it is very financially feasible for farmers and ranchers, it is regarded as one of the best types of feed in the world.

It is a fast-germinating perennial grass that can tolerate high temperatures, salinity in the soil, and water salinity. It is also an integrated element that can sustain droughts. However, its performance is low in low temperatures. It can be fed to various animals, including horses, poultry, and rabbits, and can also be used for replacement of other feeds (Oluwasola *et al.*, 2008 and Chat *et al.*,2005). Additionally, it helps to increase milk production and fattening (Euclides *et al.*, 2008; Oluwasola *et al.*, 2008 and Peres *et al.*, 2012).

MATERIALS AND METHODS

This investigation was conducted at the Animal Production Farm in Demo, which is a part of the Fayoum University's Faculty of Agriculture, Egypt. In Egypt, the University Institutional Animal Care and Use Committee (FU-IACUC) approved the execution of the experiment (the code number is 2336).

Digestibility and lactation trails:

A total number of thirty lactating buffaloes, weighing an average of 480±30 kg and ages ranging from three to five years, were divided into five groups each with six animals, using a complete random design, after two weeks of calving. The experiment lasted for sixty days. Using a fully randomized block design, buffaloes were given one of the experimental diets at a rate of 3% of their body weight once they had given birth, seven days earlier. Shehata (1971) stated that buffaloes were fed to meet their nutritional needs. The control ration, which was 60% concentrate feed mixture and 40% clover hay, was fed to the first group. The second group was fed on 60% CFM and 30% CH + 10% *Spanish panicum mombasa* (SP); the third group was fed on 60% CFM and 20% CH + 20% SP; the fourth group was fed on 60% CFM and 10% CH + 30% SP and the fifth group was fed on 60% CFM and 40% SP. The rations were provided to all experimental groups twice a day, at 8:00 am and 4:00 pm, and fresh water was available every time. Table 1 shows the chemical composition of the feed ingredients while Table 2 shows the feed ingredients' percentage of CFM, CH, and SP.

Table 1. Chemical composition of feed stuffs (%on DM basis)

Item	OM	CP	EE	CF	NFE	NDF	ADF	Ash
Concentrate feed mixture (CFM)	88.59	16.92	4.31	8.83	58.53	23.36	15.76	11.41
Clover hay (CH)	89.19	12.34	2.11	30.12	44.62	٥١,٤٥	١٥.٤٨	10.81
***Spanish panicum mombasa* (SP)**	82.68	12.92	2.34	24.65	42.77	63.56	13.32	17.32

CFM: Concentrate feed mixture (35% uncorrected cotton seed meal, 25% wheat bran, 27% yellow corn, 7% rice bran, 3% molasses, 2% lime-stone and 1% common salt), DM: Dry Matter; OM: Organic Matter; CP: Crude protein; EE: Ether extract; CF: Crude fiber; NFE: Nitrogen free extract; NDF: neutral detergent fiber; ADF: acid detergent fiber

Table 2. Formulation of experimental rations as a percent of CFM, CH and SP

Item	CFM	CH	SP
Control	60	40	0
SP10	60	30	10
SP20	60	20	20
SP30	60	10	30
SP40	60	0	40

CFM: Concentrate feed mixture, CH: Clover hay, SP: *Spanish panicum mombasa*

Apparent digestibility:

The faeces of each animal were manually removed from its rectum at 4:00 pm on the last five days of each experimental month. The animal faeces were then dried at 60 °C for 48 hours (using a hot air circulation oven, HMG India) and ground for chemical analysis. Nutrient digestion coefficients were calculated using Ferret *et al.*, (1999) acid insoluble ash technique. The following formula was used to calculate the nutrients digestion coefficients:

Digestion co-efficient =

$$100 - \left[100\, x\, \frac{\%\, indicator\, in\ feed}{\%\, indicator\, in\ feces}\, x\, \frac{\%\, nutrient\, in\ feces}{\%\, nutrient\, in\ feed} \right]$$

Feed and fecal analysis:

The percentage of dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), and ash content were determined chemically by analyzing feed stuffs and feces samples using AOAC (1999) methods. [100- (CP+ EE+ CF+ ash)] was the formula used to determine nitrogen free extract (NFE).

Collection and evaluation of blood plasma:

On the final day of each experimental month, at 12:00 pm, four hours after the morning feed was given, blood samples were taken from the jugular vein of each animal. The anticoagulant agent, EDTA, was added to glass tubes containing the blood samples, and the plasma was separated by centrifuging the tubes at 4500 rpm for 20 minutes. The obtained plasma was kept until analysis at -18°C in storage. The methods for determining albumin and plasma total protein were as reported by Armstrong and Carr (1964) and Doumas *et al* (1971), respectively. Next, the albumin/globulin ratio and globulin were calculated. The methods for determining of glutamic-pyruvic transaminase (Alanine transferase ALT), glutamic-oxidaloacetic transaminase (Aspartate transferase AST), total lipid and glucose were determined according to Postma and Stroes, 1968; Trinder, 1969, while Burtis *et al* (2006) method was used to determine cholesterol.

Milk sampling and analysis:

Throughout the trial, milk samples were collected every two weeks. Hand milking was done twice a day, at 7:00 am and 6:00 pm, on buffaloes. Following morning and evening milking, as amount of 25 ml sample of each animal's milk was taken right away, and the amount of milk produced was registered. Using a Bentley150 Infrared Milk Analyzer (Bentley

Instruments, Chaska, MN, USA), milk samples was examined for total solids (TS), fat, total protein (TP) in accordance with Ling (1963), and lactose (according to Bamett and Abd El-Tawab, 1957). Solids-not-fat (SNF) was computed. According to Rafat and Saleh (1962), the formula for calculating 7% fat corrected milk (7%FCM) was as follows: FCMY (kg) = 0.265 × milk yield + 10.5 × fat yield

Statistical analysis:

The package of SPSS for Windows, version 23, was used to statistically analyze the study's data in accordance with the following model:

$$Y_{ij}= \mu + T_i + e_{ij}$$

Where μ represents the overall mean, T_i denotes the fixed effect of treatment on the parameter under analysis, and e_{ij} represents the experimental error. Y_{ij} is the parameter under analysis of the ij *in vitro* bottle or buffalo. The significance of the differences among the means was examined using Duncan's multiple range tests (Duncan, 1955).

RESULTS AND DISCUSSION

Data of chemical compositions are shown in Table (3), while data of digestibility coefficient of dietary treatments are shown in Table (4). Digestibility of DM, OM and CP were improved for animals fed SP40 compared with all ration groups, while EE digestibility was not changed among all rations.

Table 3. Chemical composition of rations (% on DM basis)

Item	OM	CP	EE	CF	NDF	ADF	Ash	NFE
Control	88.83	15.09	3.43	17.35	14.02	9.46	11.17	52.96
SP10	88.18	15.15	3.45	16.80	20.37	12.93	11.82	52.78
SP20	87.52	15.20	3.48	16.25	26.73	16.40	12.48	52.59
SP30	86.88	15.26	3.50	15.71	33.08	19.87	13.12	52.41
SP40	86.22	15.32	3.52	15.16	39.44	23.34	13.78	52.22

SP: Spanish panicum Control =60CFM+40 SP SP10=60CFM+30CH+10SP, SP20=60CFM+20CH+20SP, SP30=60CFM+310CH+30SP, SP40=60CFM+40SP

When compared to other rations (SP20, SP10, and control), animals fed SP40 and SP30 showed significantly higher CF and NFE. Table (4) displays the nutritional value of the experimental meals as digestible crude protein (DCP) and total digestible nutrients (TDN). The DCP value of the buffaloes fed SP40 was the highest (P<0.05), followed by those fed SP30, and then those fed the control diet. The total digestible nutrients (TDN) were unchanged across all rations.

The current results are in line with those of Aregheore (2001), who discovered that goats fed gunia grass had higher (P<0.05) digestibility of OM, CP, EE, and NFE than goats fed batiki grass because gunia grass increases the ruminal cellulolytic microbial population. According to Adebisi *et al* (2016), the feed that included the largest amount of *panicum mixture* showed the best digestion in the goats.

Table 4. Digestibility coefficient and nutritive value of partially or completely substitution of clover hay by guinea grass on lactating buffaloes rations

Item, %	Control	SP10	SP20	SP30	SP40	SEM	P value
Digestibility coefficient, %							
DM	64.52^c	66.23^b	66.44^b	66.78^b	67.97^a	0.361	<0.001
OM	66.24^d	66.27^d	66.39^c	66.83^b	67.03^a	0.084	<0.001
CP	60.23^c	60.45^b	60.65^b	60.77^b	61.52^a	0.117	<0.001
EE	76.11	76.54	76.23	77.62	77.72	0.716	<0.05
CF	60.47^b	60.58^b	60.66^b	61.45^a	61.94^a	0.154	<0.001
NFE	71.35^b	71.44^b	71.51^b	72.59^a	72.78^a	0.163	<0.001
The Nutritive value, %							
TDN	65.03	65.28	65.33	66.16	67.05	0.198	<0.05
DCP	8.56^d	8.34^e	8.88^c	8.93^b	9.75^a	0.128	<0.001

DM, OM, CP, EE, CF and NFE: dry matter, organic matter, crude protein, ether extract crude fiber, nitrogen free extracts digestibility respectively. TDN: total digestible nutrients, DCP: digestible crude protein. SP10=60CFM+30CH+10SP, SP20=60CFM+20CH+20SP, SP30=60CFM+310CH+30SP, SP40=60CFM+40SP

^{a,b,c,d,e}: Means with different subscript in the same row differ significantly from each others.

Table (5) shows that the lactating buffaloes fed SP40 ration had the highest (P<0.05) values of plasma protein, globulin, ALT, and, followed by those fed SP30. The lowest values of plasma protein, globulin, ALT, and glucose levels were recorded by the buffaloes fed the control ration. Conversely, albumin, AST, total lipids, and cholesterol did not differ substantially among the buffaloes fed control ration and the other feeds, whereas the lowest values were obtained by the buffaloes fed control ration. This illustrates how *Spanish panicum mombasa* benefits both animal health and the metabolic processes. Furthermore, there were no noteworthy variations observed in the plasma albumin/globulin ratio, total lipids, or cholesterol concentrations among any of the animal groups. Notably, the blood plasma parameters measured in the experimental buffaloes groups are all within normal physiological range.

The results obtained are in line with those of Kelyni *et al.* (2022), who stated that feeding weaned baladi goat kids rations consisting of 60% concentrate feed mixture + 20% Clover hay +20% *Spanish panicum mombasa* improved (P<0.05) the serum protein, albumin, and A/G ratio. These results are found in agreement with those obtained by Yusuf *et al.* (2012).

Table 5. Effect of partially or completely substitution of clover hay by guinea grass in lactating buffaloes rations on some blood parameters

Item	Control	SP10	SP20	SP30	SP40	SEM	P value
T. protein (g/dl)	5.76^{e}	5.88^{d}	6.15^{c}	6.87^{b}	7.34^{a}	0.162	< 0.007
Albumin (A) (g/dl)	2.93	3.03	3.02	3.11	3.15	0.057	< 0.05
Globulin (G) (g/dl)	2.82^{d}	2.92^{c}	3.20^{b}	3.29^{ab}	3.35^{a}	0.056	<0.005
Albumin/Globulin ratio	1.03	1.03	0.94	0.94	0.94		
ALT (IU/L)	83.95^{e}	84.12^{d}	84.51^{c}	84.39^{b}	85.01^{a}	0.098	<0.001
AST (IU/L)	22.45	22.49	22.49	22.55	22.57	0.100	<0.05
Glucose (mg/dl)	54.32^{e}	56.33^{d}	56.33^{c}	56.35^{b}	57.23^{a}	0.357	< 0.002
T. lipids (mg/dl)	353	351	359	425	433	9.633	< 0.05
Cholesterol (mg/dl)	76.23	76.31	76.28	76.33	76.34	0.236	< 0.05

SP10=60% concentrate mixture+30% clover hay+ 10 %*Spanish panicum*, SP20=60CFM+20CH+20SP, SP30=60CFM+10CH+30SP, SP40=60CFM+40SP, Means in the same row with different superscripts are statistically different (P< 0.05).

The addition of *Spanish panicum mombasa* to the rations of buffaloes did not affect the composition of the milk; nevertheless, the yields of all milk components and milk with 7% fat corrected milk (FCM) were higher (P<0.05) in the buffaloes given the SP40 ration compared to the control and the SP30, SP20, and SP10 rations (Table 6). When compared to the control, adding SP40 to the diet increased the milk production of lactating buffaloes by 8.40% and the fat corrected milk production by 11.62%, whereas adding SP30 to their rations increased the milk production by only 2.72% and the fat corrected milk production by 7.60%.

Improved feed digestibility may lead to increased nutrient production, which in turn makes more nutrients available, explaining this reaction. A numerical downward change in the acetate to propionate ratio may also arise from an increase in ruminally fermented DM and OM, which could enhance the transport of glucogenic precursors to the mammary gland.

Table (7) shows the daily feed intake, feed efficiency, and cost-effective analysis of *Spanish panicum mombasa* diets. Overall DM consumption, energy and protein values, and the control diet did not change significantly from the other diets incorporating *Spanish panicum*; the current results were in line with those of Lorescoe*t al* (2019), Jiwuba *et al* (2017).

These results were in contrast to those of Ojo *et al* (2019), who observed a substantial difference in feed consumption between the treatments while feeding rams on *panicum* and *panicum* with the addition of legume supplements. However, when comparing diets with *Spanish panicum* to the control, feed efficiency showed significant differences (P≤0.05) in terms of DM, TDN, and DCP. The best results were obtained when comparing rations containing *Spanish panicum* (SP40) to other rations.

In terms dry matter and total digestible nutrients efficiency/kg 7% FCM, no significant differences were found between SP30, SP20, and SP10; however, when protein values were compared with all rations, the diet containing 40% *Spanish panicum* (SP40) was the highest.

These results were in contrast to those of Kelyni*et al* (2022), who reported that the feed efficiency of growing weaning Baldi goat kids may lead the researchers to suggest replacing clover hay with *Spanish panicum mombasa* at a 10% level as an efficient way to grow weaning Baldi goats' kids rations. These results supported those of Mohammed *et al.* (2021), who observed that the feed conversion efficiency of sheep fed millet silage with a 20% urea added was significantly higher (P≤0.05) than that of sheep fed *panicum maximum* hay and the millet hay without any addition.

Table 6. Effect of partially or completely substitution of clover hay by guinea grass in lactating buffalos' rations on milk yield and composition

Item	Control	SP10	SP20	SP30	SP40	SEM	P value
Milk yield (Kg/d)	8.45^{b}	8.54^{b}	8.64^{b}	8.68^{b}	9.16^{a}	0.867	<0.007
7% FCM yield (Kg/d)	6.71^{d}	6.83^{c}	6.88^{c}	7.22^{b}	7.49^{a}	0.133	<0.001
Protein yield (g/d)	188.20	192. 56	195.91	203.22	204.87		<0.05
Fat yield (g/d)	426.52^{e}	435.47^{d}	438.58^{c}	469.89^{b}	482.58^{a}	5.791	<0.001
Lactose yield (g/d)	386.9^{e}	391.00^{d}	396.75^{c}	411.82^{b}	413.91^{a}	2.942	<0.004
Ash yield (g/d)	48.84	49.48	51.23	52.42	54.71	0.563	<0.05
Total solids yield (g/d)	1044.78	1094.97	1089.35	1178.18	1249.41	19.410	<0.05
Solids not fat yield (g/d)	611.27	625.73	630.49	632.55	690.47		<0.05
Total protein	2.82	2.84	2.83	2.86	2.89		<0.05
Fat	6.03	5.97	5.97	6.15	6.22		<0.05
Lactose	5.43	6.02	6.49	6.84	6.88		<0.05
Ash	0.71	0.75	0.71	0.71	0.68		<0.05
Total solids	14.88	15.11	15.13	15.37	15.50		<0.05
Solids not fat	8.85	9.14	9.16	9.22	9.28		<0.05

SP10=60% concentrate mixture+30% clover hay+ 10 %*Spanish panicum*, SP20=60CFM+20CH+20SP, SP30=60CFM+10CH+30SP, SP40=60CFM+40SP, Means in the same row with different superscripts are statistically different (P< 0.05).

Table 7. Effect of partially or completely substitution of clover hay by guinea grass in lactating buffaloes rations on feed intake, feed efficiency and economic efficiency

Items	**Control**	**SP10**	**SP20**	**SP30**	**SP40**	**SEM**
Feed intake						
DM, kg/head	14.91	14.52	14.67	14.76	14.73	0.28
TDN, kg/head	9.70	9.48	9.58	9.77	9.88	0.16
DCP, kg/head	1.28	1.21	1.30	1.32	1.44	0.02
Feed efficiency, /kg 7% FCM						
DM, kg	2.22^{a}	2.13^{b}	2.13^{b}	2.04^{b}	1.96^{c}	0.04
TDN, kg	1.45^{a}	1.38^{b}	1.39^{b}	1.35^{b}	1.31^{c}	0.009
DCP, g	191.76^{a}	177.16^{c}	188.95^{b}	182.82^{b}	192.25^{a}	2.34
Economic efficiency						
CFM as fed, kg/head/d	8.95	8.72	8.81	8.86	8.84	
CH as fed, kg/head/d	5.96	4.35	2.93	4.43	----	
SP as fed, kg/head/d	---	1.45	2.93	1.47	5.89	
Total feed cost, LE	137.22	134.40	136.52	136.57	138.48	
Feed cost/kg FCM, LE	20.45	19.67	19.84	18.91	18.48	
Relative feed cost/kg FCM	100	96.18	97.02	92.05	90.36	

Feed cost L.E/ton of concentrate feed mixture (CFM), clover hays (CH) and *spanish panicum* (SP) were 14000, 3000 and 2500 respectively. Means in the same row with different superscripts are statistically different (P<0.05).

The presence of *Spanish panicum* in the rations decreased the cost of feed required to produce 1 kg of milk (7% FCM), as shown in Table (7), especially in rations containing 40% *Spanishpanicum* (SP40), which represented 90.36% of the total feed cost. For control, SP10, SP20, and SP30, the corresponding relative feed costs per kilogram at 4% fat corrected milk were 100, 96.18, 97.02, and 92.065%, respectively.

It could be concluded that *Spanish panicum* can effectively, economically, and safely replace up to 100% of the clover hay in lactating buffaloes' rations. In conclusion, this research offers excellent insights into animal husbandry and nutrition about the use of *Spanish panicum mombasa* as a green forage in the diets of nursing buffaloes, so contributing to the cattle industry's sustainable growth.

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تأثير الاستبدال الجزئي أو الكلي لدريس البرسيم بعلف عشبة غينيا (بونيكام مومباسا الإسبانية) على هضم العناصر الغذائية ومكونات الدم وأداء الجاموس الحلاب

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هدفت الدراسة إلى تقييم إستخدام نبات البونيكام مومباسا الإسباني كعلف أخضر وتأثيره على الجاموس الحلاب من حيث قابلية الهضم ومحصول اللبن والغذاء المأكول. تم تقسيم ٣٠ جاموسة حلابة عشوائياً إلى خمس مجاميع، غذيت المجموعة الأولى على العليقة الكنترول (٦٠٪ خليط علف مركزو٤٠٪ دريس البرسيم المصري) والمجموعة الثانية غذيت على ٦٠٪ علف مركز و٣٠٪ دريس برسيم + ١٠% بونيكام، المجموعة الثالثة غذيت على ٦٠%علف مركز+% ٢٠ بونيكام +20 %دريس برسيم، المجموعة الرابعة غذيت على ٦٠ %علف مركز +١٠ % دريس برسيم + ٣٠% بونيكام والمجموعة الخامسة ٦٠ %علف مركز + ٤٠٪ بونيكام. أدى الاستبدال الكامل لدريس البرسيم المصري بنسبة ٤٠ %من البونيكام إلى زيادة معنوية (P<0.05) فى معاملات هضم المركبات الغذائية. وكان هناك زيادة معنوية للحيوانات التى تغذت على ٤٠٪ بونيكام في قيم بروتينات البلازما والجلوبيولين وALT والجلوكوزويليها المجموعة التى تغذت على٣٠٪ بونيكام. كان هناك تحسن معنوي (P<0.05) في محصول اللبن ومعدل الدهن وكل مكونات اللبن للمجموعة التى تغذت على ٤٠٪ بونيكام عن المجموعات الأخري. سجلت الكفاءة الغذائية فروقاً معنوية (P<0.05) للعلائق المحتوية على نبات البونيكام مقارنة مع العليقة الكنترول بالنسبة للماده الجافة المأكوله، المركبات الغذائية والبروتين المهضوم. أدى الاستبدال بعلف البونيكام إلى خفض سعر العلف اللازم لإنتاج ١ كجم لبن المعدل الدهن٧٪ خاصة التي تحتوي على ٤٠٪ إلى٩٠,٣٦٪. وأخيرًا، فإن استبدال ما يصل إلى ١٠٠٪ من البونيكام بدريس البرسيم في علائق الجاموس الحلاب أثر بشكل إيجابي على تحسين هضم العناصر الغذائية وإنتاج اللبن وخفض أسعار العلف اللازمه لذلك.