# PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF BARKI EWES FED ON *CASSAVA, ACACIA OR ATRIPLEX* AS AN ALTERNATIVE OF BERSEEM HAY

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## SUMMARY

The comparative evaluation of different less-well researched forages will yield promising candidates to overcome the limitations of feed sources in most sub-tropic areas during drought. These resources may provide enough supply for animals' growth and milk production. Therefore, the main objective of the present study was to investigate the effect of using the viability of complete replacement of berseem hay in the diet of Barki ewes with cassava, or *Acacia neloitca* or *Atriplex halimus* leaves on ewes and their lambs' performance. For this berseem hay, "BH" in the diets of sheep was substituted with leaves of cassava, acacia or Atriplex. Forty late pregnant Barki ewes (43.2±1.1 Kg body weight) were divided into four groups in this evaluation trial. Animal groups fed either control diet (900 g concentrate feed mixture "CFM" + 600 g BH), or the tested diets, in which substituted BH with 600 g leaves of cassava, acacia, or Atriplex. Biweekly live body weight of ewes was recorded in the morning before feeding, while their lambs were weighed at the birthing then biweekly until weaning. Digestibility trials and nitrogen balance were implemented for the tested diets. Milk yield and its composition as well as blood analysis were also carried out. The economic efficiency was calculated for the experimental groups. Data of the studied parameters were statistically analyzed using the General Linear Model's procedures of SAS GLM (SAS, (2004). Cassava recorded the highest ($P<0.05$) values of most digestibility coefficients and feeding value parameters as well as dry matter intake and nitrogen balance. Both cassava and acacia were the best ones in maintaining the body weight and weight gain for both ewes and their lambs compared to the control and Atriplex groups. Milk yield was increased ($P<0.01$) in the cassava diet and milk protein, fat, ash, and solid not fat were increased ($P<0.05$) in the substituted forage diets compared with the control. Somatic cell count was almost similar in all tested groups. Cassava group had higher ($P<0.05$) serum total protein and the lowest A/G ratio, urea, and creatinine concentrations when compared to the control. Cassava increased ($P<0.05$) lambs weaning weights and daily weight gain compared to other treatments. It could be concluded that cassava, acacia and Atriplex are valuable alternatives to berseem hay in Barki ewe diets. Ewes fed cassava tended to have high body weight, milk yield and their lamb's daily gain compared with that fed acacia or Atriplex.

***Keywords:*** *Ewes, cassava, acacia, atriplex, digestibility, blood, milk.*

## INTRODUCTION

The annual feed requirements of livestock in Egypt are about 14 million tons of total digestible nutrients (TDN), while the available is only 10 million tons with shortage of 4 million tons of (FAO, 2008). The major limitation to ruminant production especially in semi-arid regions of Egypt is poor nutrition, especially in the dry season. Livestock feeding is facing serious difficulties related to the quantitative and qualitative provision of nutrients and this is exacerbated by the continuous increase of feedstuffs' prices. So, there was a dire need felt to explore new feed resources. The livestock, mostly small ruminants, depend on the diet provided for a part of tree, shrubs grazing, and mostly by complements, crop residues (cereals, vegetables, etc.), and some forages. Poor quality roughages comprise the only part of the diet for ruminant animals in the most Egyptian desert for a considerable part of the year. Animals on such diets are on negative energy balance and supplementary feeding with energy and nitrogen has been used for improving the nutritional status of animals. Egyptian desert represents more than 75% of Egypt area, in this desert, the most common vegetation along the grazing areas is halophyte and salt-tolerant plants. Trees and shrubs have been used as supplements for animals kept under extensive systems of production. The wider application of such resources is restricted due to lack of energy in certain countries and/or areas within countries, and the major limitation with *Tamarixs mannifera*, *Atriplex nummularia*, *Prosopis juliflora* and *Acacia saligna* includes their poor nutritive value, low palatability and their content of some anti-nutritional factors (ANF's) such as tannins, alkaloids, oxalates and flavonoids and high contents of some mineral (El-Shaer, 2010).

Animal nutrition scientists had to think about the optimal use of such salty plants for feeding ruminants in such far semi-arid areas. Feeding animals using salty shrubs (halophytes) needs to pay attention to its sufficiency in covering animal needs from nutrients throughout benefiting the antimicrobial properties of plant secondary metabolites (PSM), e.g. tannins and essential oils which are present in high percentages in these plants. Within this frame, animal feeding strategies depended on the dietary manipulation approach and implemented it in the forms of either improving forage quality or changing feed resources proportion in the diet. The results of PSM were found to motivate fermentation and maintain efficient utilization of feeds throughout increasing degradability of CP and cell-wall components. This action resulting in increased microbial protein synthesis in the rumen via improving the synchronization between energy and protein release Moradi-kor and Bayati Zadeh (2013). These PSM are defined as anti-nutritional substances that affect the digestibility and nutritive value of these shrubs. The incorporation of these shrubs as forages into animal mixed diets or mixing it with other feed resources may introduce a reasonable solution for replacing the traditional roughages as hay (Feeding coast effective factor) and the animals can consume it overcoming the palatability obstacle Swingle *et al.* (1996). Various studies as reviewed by Singh *et al.* (2019) reported that halophytic plants may introduce a suitable alternative to enhance the availability of agricultural feed resources along with many ecological facilities, especially in the saline areas. Under arid and semi-arid conditions, Mohammady *et al.* (2014) concluded that allowing sheep to graze more than one kind of halophytic forages e.g. *Atriplex halimus* and *Acacia neloitca* is desirable to overcome the palatability limiting factors. They did not recorded severe biological disorders and had no significant effect due to type of feed on live body weight and average daily gain of Barki ewes and lambs fed either berseem hay or halophytic silage.

Therefore, the main objective of the present study was to investigate the effect of using the viability of complete replacement of berseem hay in the diet of Barki ewes with *Cassava (Manihot esculenta)* or *Acacia neloitca* or *Atriplex halimus* leaves on ewes and their lambs' performance parameters.

## MATERIALS AND METHODS

The current investigation was conducted at Borg El-Arab Livestock Research Station, Animal Production Research Institute, Ministry of Agriculture, Egypt.

***Ewes and lambs performance:***

Forty Barki ewes at the last third of pregnancy period, aged 3-5 years old with an average live body weight of 43.0±0.3 Kg, were randomly allocated to four treatment groups (Ten ewes each) according to their weights and age. All animals were kept in a semi-open shaded yard and kept under the same managerial conditions during the experimental period. The experimental period lasted for 12 weeks, 4 weeks pre-partum, and 8 weeks post-partum. Before starting the experiment, animals were treated against internal and external parasites and intro-toxemia. Biweekly live body weight of ewes was recorded in the morning before feeding and their lambs were weighed at the birthing then biweekly until weaning.

***Experimental feedstuffs:***

The requirements of digestible crude protein (DCP) and metabolizable energy (ME) for ewes at the last period of pregnancy were calculated according to the recommended feeding standards of Kearl (1982). The amounts of offered and refused feeds were daily weighed to determine total dry matter intake (DMI). Samples of feed and refusals were oven-dried at 105°C to determine dry matter (DM) content and total DMI. The experimental diets were prepared to replace berseem hay in the control diet T1: (60% Concentrate Feed Mixture "CFM"+ 40% Berseem Hay "BH", on DM basis) with leaves of salt tolerant forages as follows: T2: 60% CFM + 40% cassava leaves, T3: 60% CFM + 40% acacia leaves and T4: 60% CFM + 40% atriplex leaves.

Ewes had free access to fresh tap water during all the experimental period. Ground samples of feeds, diets and faeces were analyzed for DM, total ash and N content. Crude protein (CP) in feeds, faeces and acidified urine was determined using Micro-Kjeldahl method (where: CP = 6.25 × N) according to the procedures described by A.O.A.C. (1995). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) analyzed according to method of Van Soest *et al.* (1991). Organic matter (OM) contents were calculated by difference (by subtracting ash from DM). Extractable condensed tannins (CT) in all ingredients and diets offered were estimated by Butanol-HCl method according to Makkar (2003). The results of feed ingredients analysis are presented in Table (1).

**Table (1):Chemical analysis (% on DM basis) of the experimental feed ingredients.**

| Feedstuffs | Chemical composition | | | | | | | Fiber Fractions | | | NSC | CT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DM | OM | CP | CF | EE | NFE | Ash | NDF | ADF | ADL | (%) | (g/kg DM) |
| Berseem hay | 95.12 | 89.59 | 10.64 | 38.54 | 1.03 | 39.38 | 10.41 | 55.89 | 43.27 | 37.16 | 22.03 | 0 |
| CFM* | 91.20 | 93.90 | 15.70 | 14.23 | 3.13 | 60.84 | 6.10 | 43.00 | 17.30 | 5.80 | 32.07 | 0 |
| *Cassava Manihot esculenta* | 88.76 | 92.26 | 22.94 | 28.05 | 2.92 | 38.35 | 7.74 | 45.14 | 33.28 | 19.47 | 20.76 | 20.58 |
| *Acacia neloitca* | 90.02 | 90.18 | 15.99 | 31.59 | 3.66 | 38.94 | 9.82 | 52.55 | 34.77 | 48.96 | 17.98 | 15.61 |
| *Atriplex halimus* | 92.42 | 74.57 | 12.84 | 25.03 | 1.40 | 35.3 | 25.43 | 55.70 | 40.45 | 14.50 | 4.63 | 24.25 |
| Calculated chemical composition of the tested rations** | | | | | | | | | | | | |
| T1 | 92.77 | 92.18 | 13.68 | 23.95 | 2.29 | 52.26 | 7.82 | 48.16 | 27.69 | 18.34 | 28.05 | 0.00 |
| T2 | 90.22 | 93.24 | 18.60 | 19.76 | 3.05 | 51.84 | 6.76 | 43.86 | 23.69 | 11.27 | 27.55 | 8.23 |
| T3 | 90.73 | 92.41 | 15.82 | 21.17 | 3.34 | 52.08 | 7.59 | 46.82 | 24.29 | 23.06 | 26.43 | 6.24 |
| T4 | 91.69 | 86.17 | 14.56 | 18.55 | 2.44 | 50.62 | 13.83 | 48.08 | 26.56 | 9.28 | 21.09 | 9.70 |

*DM= Dry matter; OM= Organic matter; CP= Crud protein; EE= Ether extract; CF= Crud fiber; NFE= Nitrogen Free Extract; NDF= Neutral detergent fiber; ADF= Acid Detergent Fiber; ADL= Acid Detergent Lignin; CT= condensed tannins.*

** CFM: Concentrate feed mixture consisted of 25% un-decorticated cotton meal, 43% yellow corn, 25% wheatbran, 3.5% molasses, 2% limestone, 1% common salt and 0.5% minerals mixtures. NSC (Non-structural carbohydrate) % = 100 – [% NDF + % CP + % fat + % ash] Calsemiglia et al. (1995). CT: Condensed Tannins.*

*** The tested rations: T1: (60% Concentrate Feed Mixture "CFM"+ 40% Berseem Hay "BH", on DM basis) with leaves of salt tolerant forages as follows: T2: 60% CFM + 40% cassava leaves, T3: 60% CFM + 40% acacia leaves and T4: 60% CFM + 40% atriplex leaves.*

***Digestibility trial and nitrogen balance:***

Twelve Barki rams were used in the digestibility trial, aged 1-2 years with average body weight of 45±1.85 Kg. Rams were housed individually in metabolism cages randomly (3 rams each) and assigned to the four dietary treatments. Drinking water was freely choice, and daily feed intake, faeces and urine were recorded every morning. Feed and faeces was determined by drying to a constant weight in a forced air oven at 55°C, then ground to pass through a 1 mm screen and preserved for chemical analysis. Nitrogen (N) balance values were mathematically calculated by subtracting (faecal N + urine N) values from total N intake values.

***Milk yield and composition:***

During suckling period, milk yield for individual ewes was recorded twice daily at 7 am and 5 pm during the suckling period (8 weeks) using the technique of weigh-suckle-weigh (WSW) according to Ünal *et al.* (2007). From birth day, lambs were all time with their dams and fed on dam's milk up till weaning age (8 weeks). The day before recording, lambs were separated from their dams at 5 pm for the whole evening. In the following day, morning at 7 am, lambs were weighed and allowed to suckle their dams for 15 minutes period. Their body weights were then recorded and after finished suckling, ewes were hand milked to remove any residual milk. The amount of daily milk yield of the ewe was calculated from the difference in weight of the lamb before and after suckling plus the amount of milk by hand milking. Individual milk samples (100 ml) were hand milked of both sides of the udder from all ewes in each group weekly through lactation period and pooled into one sample per ewe. Milk samples were directly analyzed for concentrations of fat, protein, lactose and total solids using a milk Oscan device (Mark®, 133B, N. FOSS, Electric, Denmark).

***Blood analysis:***

Blood samples were collected biweekly during experimental periods from the jugular vein of ewes into clean test tubes with anticoagulant. Blood samples were centrifuged at 3000 rpm for 20 minutes to obtain plasma and frozen at -20C˚ for late biochemical assay. Plasma concentrations total proteins, albumin, liver activity enzymes and kidney functions were estimated calorimetrically using commercial chemical reagent kits (Bio-diagnostic product Kit, Egypt). However, globulin concentration and Albumin/globulin ratio was calculated.

***Economic efficiency:***

Based on local prices, economic efficiency was determined as total output/total input (where one-ton of CFM, hay, CA, AN, At. & Kg BW/lambs were 4500, 2500, 550, 550, 500 & 65 L.E, respectively).

***Statistical analysis:***

Live body weights of ewes and their offspring, reproductive performance, average weekly milk yield, milk composition and blood parameters were statistically analyzed using the General Linear Model's procedures of SAS GLM (SAS, 2004), the model includes the effect of treatments. Means were tested using Duncan's Multiple Range test procedure (Duncan, 1955).

## RESULTS AND DISCUSSION

It is of interest to notice from Table (1) that the three tested plants covers CP minimum requirement (7%) of rumen microbes reported by McDonald *et al.* (2002). This amount support ruminal microbial activity and ruminant maintenance requirement. Both cassava and acacia contained higher NSC and lower CT contents than atriplex (Table 1). This may be of benefits to the experimental animals in terms of feed intake. As reviewed and discussed by El-Deeb *et al.* (2005) higher concentrations of NDF limited the intake through rumen fill. Moreover, the intake from diets with low NDF level was limited by the energy requirements of the animals which negatively related to NDF content. Condensed tannin (Polyphenol macromolecule) was the highest in atriplex that may participate in reducing feed intake and relative feeding value compared to diets contained cassava and acacia (Table 2). In this concern, Wachenheim *et al.* (1992) reported earlier that rumen microorganisms found to have the ability to degrade low concentration of alkaloids, saponins Hart *et al.* (2008)

and phenolics Varel *et al.* (1991) and utilizes them as an energy source without negative effects on rumen fermentation.

***Feed intake and evaluation of the tested diets:***

Data in Table (2) showed that the lowest consumed diet was recorded with animals fed atriplex followed by acacia and cassava, respectively and the last group (Cassava) recorded the highest (P<0.05) feed intake. Digestibility coefficients of DM, OM, CP, EE, and CF were higher in animals that received cassava than those fed either acacia and/or atriplex. Moreover, the rich content of cassava and acacia from eNDF, gross and digestible energy reflected positively on the relative feeding value of the tested plants compared to the atriplex fed group.

**Table (2): Intake, nutrients digestibility, nitrogen balance and nutritive value of the experimental diets.**

| Item | Experimental diets | | | | SEM |
|---|---|---|---|---|---|
| | Control | *Cassava Manihot esculenta* | *Acacia neloitca* | *Atriplex halimus* | |
| DM intake (g/day) | 957.68[a] | 975.48[a] | 898.41[b] | 864.62[c] | 6.51 |
| Digestion coefficients (%) | | | | | |
| Dry matter, DM | 53.68[a] | 55.54[a] | 50.16[b] | 38.97[c] | 1.02 |
| Organic matter, OM | 54.85[a] | 55.18[a] | 49.69[b] | 37.91[c] | 1.24 |
| Crude protein, CP | 57.92[a] | 58.25[a] | 43.40[b] | 38.49[c] | 1.07 |
| Ether extract, EE | 53.43[b] | 57.62[a] | 56.74[a] | 53.44[b] | 0.81 |
| Crude fiber, CF | 43.70[b] | 49.28[a] | 41.68[b] | 40.25[c] | 1.10 |
| Neutral detergent fiber, NDF | 65.84[b] | 67.03[a] | 65.23[b] | 63.76[c] | 0.77 |
| Acid detergent fiber, ADF | 61.12[b] | 62.58[a] | 61.09[b] | 60.15[c] | 0.41 |
| Effective neutral detergent fiber (eNDF) | 20.69[bc] | 24.47[a] | 25.42[a] | 19.98[c] | 1.17 |
| Relative feeding value (RFV) | 39.87[b] | 42.02[a] | 34.92[c] | 26.13[d] | 3.06 |
| Gross Energy (GE, MJ/Kg DM) | 1.79[a] | 1.84[a] | 1.82[a] | 1.68[b] | 0.07 |
| Digestible Energy (DE, Mcal/Kg DM) | 2.14[a] | 2.01[b] | 2.03[b] | 1.80[c] | 0.06 |
| Nitrogen utilization (g/h/d): | | | | | |
| N intake | 12.83[a] | 12.83[a] | 10.90[b] | 9.53[c] | 0.62 |
| N output | 12.30[a] | 12.30[a] | 10.12[b] | 9.22[c] | 0.62 |
| N balance | 0.28[d] | 0.78[a] | 0.53[b] | 0.33[c] | 0.02 |
| Nutritive value, %: | | | | | |
| TDN | 48.51[a] | 45.59[b] | 46.09[b] | 40.73[c] | 1.22 |
| DCP | 4.21[a] | 4.46[a] | 3.76[b] | 3.23[c] | 0.04 |

*a, b, c, d: Means with different letters in the same row are significantly different (P<0.05).*
*eNDF (Effective neutral detergent fiber) = (pH - 5.425) / 0.04229 (Fox et al., 2000)*
*RFV = DMI x DDM / 1.29 (Moore and Coleman, 2001)*
*GE (MJ/Kg DM) = 0.0226 CP+0.0407 EE+0.0192 CF+0.0177 NFE. (MAFF, 1975)*
*DE (Mcal/Kg DM) = % TDN x 0.04409 (NRC, 1978)*

The obtained trends of tested plants are in harmony with the results of El-Deeb *et al.* (2010) who stated that RFV and DE are accompanied by a reduction in values, especially with increased NSC content (as rumen un-degradable protein source). They also stated that the RFV and DE values were higher in diets that contained high rumen degradable NSC than those with low ones and with low rumen degradable protein than those with high ones. The lower NSC content of atriplex may be of limitations to the rumen behavior and nutrient digestibility. While NSC percentage in the whole formulated diet of both cassava and acacia fall within the range reported by Wheeler (2003) in the total ration dry matter (not below 20-25% nor go above 40-45%). In this regard, Najmul Haque (2018) stated that a low structural fiber diet, in the long term, disturbs rumen function by causing sub-acute or acute acidosis, thus reducing the rumen fermentation and accordingly feed utilization. The cassava group ration recorded the highest nitrogen balance and digestible crude protein (DCP) with lower total digestible nutrients (TDN) than the control, while it remained the best resource compared to acacia and atriplex, respectively.

***Performance of ewes and their lambs:***

The results presented in Table (3) showed that ewes fed both cassava and/or acacia gained more weight significantly (P<0.05) compared to the other two groups. In the meantime, ewes in the control and atriplex groups recorded the highest significant (P<0.05) weight loss of pre-lamping. Cassava group gave the highest (P<0.05) total gain as well as daily body gain in the live weight of Barki lambs followed by the groups of acacia and the control, while atriplex group recorded the lowest (P<0.05) values. These positive results in live body weight and weight gain can be attributed to better feed utilization of diets contained cassava leaves compared to the other tested diets. The content of tested shrubs from CT might play a role in benefitting the diets energy and N-utilization for live body weight and weight gain of tested animals. Since the diets contained lower content of CT (cassava and acacia) recorded better results than that contained the highest value of CT (atriplex). Binding tannins with dietary protein generated stable protein-tannins complex at rumen pH and reduced the proteolytic activity and protect protein from degradation.

In this concern, Hassan *et al.* (2015) indicated that low concentrations of condensed tannin may support its binding with dietary protein and with structural polysaccharides and slowed their degradation rate, thereby, reduced ruminal protein degradability and plant cell wall digestion. The obtained results can be explained by the assumption of Mueller-Harvey (2006) that CT reduces palatability, digestibility and consequently feed intake because of its astringent property which cause negative correlation between DM intake as well as fiber fractions and CT.

In support with the present study findings, results obtained by Khoung and Khang (2005) which reported that increasing levels of fresh cassava foliage increased total DM intake and rate of live weight gain. Moreover, El-Gohary *et al.* (2017a) recorded better impact (growth rate or feed conversion efficiency and economic values) on growing Barki lambs when fed cassava or prosopis (leaves & twigs) with ammoniated wheat straw and concentrate feed mixture. They concluded also that, under the semi-arid conditions, the complete diet of growing Barki lambs and contain up to 60% combinations of cassava and ammoniated wheat straw with *Prosopis juliflora* or *Acacia saligna* significantly (P<0.05) increased their daily body gain (DBG).

**Table (3): Effect of feeding tanniniferous shrubs compared with berseem hay on performance of Barki ewes and their lambs.**

| Item | Experimental diets | | | | SEM |
|---|---|---|---|---|---|
| | Control | *Cassava Manihot esculenta* | *Acacia neloitca* | *Atriplex halimus* | |
| Ewes performance | | | | | |
| Initial Body Wt. (Kg) | 43.40±4.20 | 43.10±7.10 | 43.20±5.62 | 43.10±6.20 | 0.05 |
| Final Body Wt. (Kg) | 48.50±4.20$^c$ | 50.75±7.10$^a$ | 49.60±5.62$^b$ | 46.80±7.20$^d$ | 0.26 |
| Gain (Kg) | 5.30±3.64$^a$ | 7.85±5.12$^a$ | 6.50±4.81$^b$ | 4.00±5.44$^d$ | 0.05 |
| ADG (g/day) | 94.64±6.20 | 142.72±6.50 | 116.07±5.60 | 71.43±4.30 | 0.38 |
| Loss in body weight at lambing | | | | | |
| Body Wt. after lambing (Kg) | 38.20±4.20 | 42.85±7.10 | 41.10±5.62 | 35.30±6.20 | 0.07 |
| Loss (Kg) | 10.5±0.78$^b$ | -7.9±0.70$^d$ | -8.5±0.62$^c$ | -11.5±0.43$^a$ | 0.03 |
| Loss % of pre-lamping | 21.65±3.35$^b$ | 15.57±2.28$^d$ | 17.14±3.60$^c$ | 24.57±5.28$^a$ | 0.05 |
| Lambs performance | | | | | |
| Lamb birth weight (Kg) | 3.4±0.43$^c$ | 4.2±0.52$^a$ | 3.6±0.40$^b$ | 3.0±0.30$^d$ | 0.02 |
| Lamb weaning weight (Kg) | 10.8±0.66$^c$ | 14.3±0.72$^a$ | 11.1±0.68$^b$ | 9.9±0.54$^d$ | 0.31 |
| Lamb daily weight gain (g/d) | 132±0.28$^c$ | 180±0.68$^a$ | 141±0.53$^b$ | 123±0.42$^d$ | 0.01 |

*a, b, c, d: Means with different letters in the same row are significantly different (P<0.05).*
*SEM =Standard error of mean.*

The present work results comes on line with findings by Mohammady *et al.* (2014) who reported higher significant differences in daily gain of Barki lambs fed BH when compared with those fed halophytic plants. On the other hand, Sadek *et al.* (2020) recorded non-significant differences between ewes fed acacia, atriplex and cassava when compared with those fed BH in total gain and average daily gain of lambs. Moreover, Shaker *et al.* (2014), on some salt tolerant fodder shrubs mixture, concluded that the age of the leaves at harvest, the soil type and fertility as well as the agro-ecological system under which trees were grown are the most effective factors of results variation.

***Reproductive performance of ewes:***

Data presented in Table (4) show significant (P<0.05) differences in No. of total born, No. of total weaning, litter size at birth, litter size at weaning, type of birth, and viable lambs produced from different experimental groups. The average No. of total born, No. of total weaned lambs, litter size at birth, litter size at weaning and viable lambs was significantly (P<0.05) higher in treatment groups *Cassava manihotesculenta* and *Acacia neloitca* groups than in *Atriplex halimus* and control groups. These results may be attributed to the reason that ewes received the adequate requirements of nutrients, especially protein and energy, from the tested shrubs compared to the control.

**Table (4): Reproductive performance of ewes and viable lambs in the experimental groups (Mean±SE).**

| Item | Experimental diets | | | |
|---|---|---|---|---|
| | Control | *Cassava Manihot esculenta* | *Acacia neloitca* | *Atriplex halimus* |
| No. of ewe does | 10 | 10 | 10 | 10 |
| No. of total born | 10 | 12 | 11 | 10 |
| No. of total weaning | 9 | 12 | 11 | 9 |
| Litter size at birth | 1 | 1.2 | 1.1 | 1 |
| Litter size at weaning | 0.9 | 1.2 | 1.1 | 0.9 |
| Type of birth | | | | |
| Single (n-%) | 10 (100%) | 8 (80%) | 9 (90%) | 10 (100%) |
| Twins (n-%) | 0.0 | 2(20%) | 1(10%) | 0.0 |
| No. of Kg born | 3.69±0.10 | 3.83±0.20 | 3.75±0.13 | 3.79±0.17 |
| No. of Kg wean | 11.98±0.19 | 11.53±0.85 | 11.25±0.95 | 11.83±0.50 |
| Viable Lambs (n-%) | | | | |
| At birth (n-%) | 10 (100%) | 12 (100%) | 11 (100%) | 10 (100%) |
| At weaning (n-%) | 9 (90%) | 12 (100%) | 11 (100%) | 9 (90%) |

The high content of ash in atriplex may be the reason behind recording lower values of the studied ewes reproductive characters (Table 4), since it reduced the available OM and CP than those in cassava and acacia diets. This means that feeding ewes during late pregnancy and postpartum period on different forage types as alternative to BH in this study was save without adverse effects on the reproductive performance of ewes. These results are in agreement with Fasae *et al.* (2015) and El-Gohary *et al.* (2017b).

***Milk production and composition:***

Results presented in Table (5) showed significant differences in daily, weekly, and total milk yield among the experimental groups throughout a lactation period of 8 weeks. Ewes fed Cassava diet had significantly (P<0.05) higher milk yields than that of other groups. Throughout 8 lactation weeks during the suckling period, average weekly milk yield showed the same trend of change, showing gradual increase after lambing reaching its peak at the 3$^{rd}$ wk of lactation in all groups, and then it gradually decreased up to 8 weeks of lactation. Milk yield of Barki ewes significantly (P<0.05) improved with feeding cassava leaves than the other two tested resources and the control group (Table 5). This improvement in cassava diet group may be attributed to positive energy balance as well as the increased nutrient utilization. According to these results, ewes in all groups had a negative energy balance during the early postpartum period till 3 weeks after lambing, but the observed group differences in milk yield may be due to variation in the nutritional state of ewes. Accordingly, the obtained results may indicate the impact of feeding ewes during the pre-and post-partum period on diet containing CFM plus cassava or acacia on milk yield during the suckling period. Close results were found by Anantasook *et al.* (2014) who recorded 10% increase in milk yield of cows fed 88 g/Kg DM condensed tannin. On the other hand, Maamouri *et al.* (2011) showed that feeding high level of acacia to ewes significantly decreased milk production.

Milk fat and protein of Barki ewes significantly (P<0.05) improved with feeding cassava leaves than the other two tested resources and the control group, this results may be attributed to the higher digestibility coefficients of the nutrients in cassava leaves than those in berseem hay, Acacia leaves and atriplex (Table 6). Feeding ewes the three tested plants significantly (P<0.05) increased their milk content from solids not fat and ash than that recorded with the control group in general. Somatic cell count did not show any significant changes among tested groups reflecting the healthy conditions of the experimented animals. The results obtained herein, especially with using atriplex which contained the highest content of ash, supposed to decrease total volatile fatty acids (VFA) productions in the rumen and digestion coefficients and the subsequent reduction in the availability of VFA and nutrients in the small intestine.

**Table (5): Impact of feeding tanniniferous shrubs on average daily milk yield (kg), average weekly milk yield and total milk yield of Barki ewes during suckling period.**

| Lactation period (week) | Experimental diets | | | | SEM |
|---|---|---|---|---|---|
| | Control | *Cassava Manihot esculenta* | *Acacia neloitca* | *Atriplex halimus* | |
| 1st wk. | 3.850±0.31[c] | 4.550±0.29[a] | 4.340±0.31[b] | 2.800±0.26[d] | 0.08 |
| 2nd wk. | 4.690±0.48[c] | 5.740±0.50[a] | 4.900±0.64[b] | 3.640±0.16[d] | 0.01 |
| 3rd wk. | 4.900±0.71[c] | 6.160±0.46[a] | 5.040±0.30[b] | 3.850±0.34[d] | 0.01 |
| 4th wk. | 4.550±0.48[c] | 5.810±0.37[a] | 4.760±0.28[b] | 3.500±0.08[d] | 0.03 |
| 5th wk. | 4.200±0.47[c] | 5.180±0.48[a] | 4.340±0.32[b] | 3.150±0.26[d] | 0.01 |
| 6th wk. | 3.500±0.28[c] | 4.396±0.46[a] | 3.850±0.31[b] | 2.800±0.32[d] | 0.01 |
| 7th wk. | 3.150±0.24[c] | 3.759±0.34[a] | 3.360±0.43[b] | 2.450±0.13[d] | 0.03 |
| 8th wk. | 2.800±0.36[c] | 3.346±0.38[a] | 2.940±0.32[b] | 2.100±0.13[d] | 0.01 |
| Total milk yield/Kg/h | 31.640 | 38.941 | 33.530 | 24.290 | 0.03 |
| Average daily milk yield (kg/h/d) | 0.565±0.8[c] | 0.695±0.12[a] | 0.599±0.12[b] | 0.433±0.07[d] | 0.01 |

*Data are mean values (n=10), SEM =Standard error of the mean.*
*a,b,c: Means with different letters in the same row are significantly different (P<0.05)*

**Table (6): Effect of feeding tanniniferous shrubs compared with berseem hay on** milk **composition and somatic cell count of Barki ewes.**

| Item | Experimental diets | | | | SEM |
|---|---|---|---|---|---|
| | Control | *Cassava Manihot esculenta* | *Acacia neloitca* | *Atriplex halimus* | |
| Fat | 4.75[b] | 5.15[a] | 4.85[b] | 3.95[c] | 0.08 |
| Protein | 3.65[b] | 3.98[a] | 3.84[a] | 3.66[b] | 0.01 |
| Lactose | 5. 20 | 5.40 | 5.12 | 4.83 | 0.01 |
| Solids not fat | 9.72[c] | 10.6[b] | 11.8[a] | 10.7[b] | 0.03 |
| Ash | 0.52[c] | 0.78[b] | 0.79[a] | 0.80[b] | 0.001 |
| Somatic cell count (log) | 2.32 | 2.32 | 2.29 | 2.39 | 0.02 |

*Data are mean values (n=10), SEM =Standard error of the mean.*
*a,b,c: Means withdifferent letters in the same row are significantly different (P<0.05)*

El-Gohary *et al.* (2017a) reported considerable variability in milk constituents among tested groups with unclear effect for condensed tannin concentration since milk composition (fat, protein, and lactose) among tested groups was not significantly different. They added that ewes fed the high condensed tannin content in the diets showed a trend towards low percentages of different milk components. Abdalla *et al.* (2013) reported that fat percentage in goat milk was not affected by the type of roughage. Ahmed *et al*. (2013) found no effect to feeding tanniniferous plants shrubs on milk constituents. Moreover, Shetaewi *et al.* (2001) reported that milk fat percentages decreased in does fed concentrate diet plus green Acacia in comparison to those fed concentrate diet plus BH. They attributed this result to the higher digestibility coefficients of the nutrients in berseem hay than those in Acacia leaves. Moreover, El-Saadany *et al.* (2016) found that there was no significant reduction in fat content of ewes' milk when fed cassava as compared to other tested groups during the whole lactation period

***Blood parameters:***

Regarding blood parameters of the experimental ewes, data (Table 7) cleared that there were no significant differences among tested groups in all tested parameters, except blood urea content and the concentration of aspartate aminotransferase (AST). Acacia group recorded the lowest values of total protein (TP), albumin (A), and globulin (G), while cassava group recorded the lowest values of A/G ratio, urea, and creatinine. In this concern, Shahen *et al.* (2004) mentioned that the increase in digestibility of CP led to increasing total protein and its fractions. The increase in plasma total proteins in all treatments might be regarding the increased plant's crude protein. Kumar *et al.* (1980) reported a positive correlation between dietary protein and plasma protein concentrations. Another explanation could be an indication of the protein quality of the leaf Iheukwumere *et al. (*2007). The highest mean albumin was recorded by lambs fed atriplex and cassava. In general, plasma protein is.

**Table (7): Effect of feeding tanniniferous shrubs compared with berseem hay on blood parameters of Barki ewes.**

| Item | Sampling time | Experimental diets | | | | SEM |
|---|---|---|---|---|---|---|
| | | Control | *Cassava Manihot esculenta* | *Acacia neloitca* | *Atriplex halimus* | |
| Total protein (TP, g/dl) | Pre-parturition | 7.54±1.18 | 7.75±1.33 | 7.27±1.33 | 7.64±1.33 | 0.08 |
| | At lambing | 8.64±1.20 | 8.85±1.34 | 8.38±1.34 | 8.75±1.34 | 0.09 |
| | At weaning | 9.74±1.22 | 9.95±1.36 | 9.49±1.36 | 9.86±1.36 | 0.10 |
| | Overall mean | 8.64±1.21 | 8.85±1.35 | 8.38±1.35 | 8.75±1.35 | 0.09 |
| Albumin (A, g/dl) | Pre-parturition | 1.52±0.18 | 1.54±0.17 | 1.41±0.19 | 1.69±0.19 | 0.03 |
| | At lambing | 2.63±0.19 | 2.65±0.21 | 2.52±0.20 | 2.70±0.20 | 0.04 |
| | At weaning | 3.74±0.20 | 3.76±0.32 | 3.63±0.33 | 3.71±0.17 | 0.05 |
| | Overall mean | 2.63±0.19 | 2.65±0.21 | 2.52±0.21 | 2.70±0.21 | 0.04 |
| Glubulin (G, g/dl) | Pre-parturition | 3.21±1.14 | 3.51±1.12 | 3.10±1.18 | 3.11±1.14 | 0.06 |
| | At lambing | 4.84±1.28 | 4.61±1.30 | 4.05±1.22 | 4.19±1.26 | 0.07 |
| | At weaning | 5.42±1.56 | 5.62±1.60 | 5.20±1.88 | 5.40±1.58 | 0.08 |
| | Overall mean | 4.42±1.28 | 4.61±1.43 | 4.10±1.43 | 4.20±1.43 | 0.07 |
| A/G ratio | Pre-parturition | 0.51±10.20 | 0.47±10.24 | 0.50±10.24 | 0.52±10.24 | 0.08 |
| | At lambing | 0.60±10.20 | 0.58±10.24 | 0.61±10.24 | 0.64±10.24 | 0.09 |
| | At weaning | 0.79±10.20 | 0.69±10.24 | 0.72±10.24 | 0.78±10.24 | 0.10 |
| | Overall mean | 0.60±10.20 | 0.58±10.24 | 0.61±10.24 | 0.64±10.24 | 0.09 |
| Urea-N (mg/dl) | Pre-parturition | 38.57±3.08[a] | 21.70±2.76[c] | 35.72±3.08[b] | 40.56±3.08[a] | 0.04 |
| | At lambing | 49.68±3.08[a] | 59.88±2.76[c] | 45.83±3.08[b] | 50.67±3.08[a] | 0.05 |
| | At weaning | 60.49±3.08[a] | 40.99±2.76[c] | 55.94±3.08[b] | 60.78±3.08[a] | 0.06 |
| | Overall mean | 49.68±3.08[a] | 40.89±2.76[c] | 45.83±3.08[b] | 50.67±3.08[a] | 0.05 |
| Creatinin (mg/dl) | Pre-parturition | 0.54±0.02 | 0.53±0.02 | 0.56±0.02 | 0.55±0.08 | 0.07 |
| | At lambing | 0.65±0.02 | 0.64±0.02 | 0.67±0.02 | 0.66±0.08 | 0.08 |
| | At weaning | 0.76±0.02 | 0.75±0.02 | 0.78±0.02 | 0.77±0.08 | 0.09 |
| | Overall mean | 0.65±0.02 | 0.64±0.08 | 0.67±0.13 | 0.66±0.08 | 0.08 |
| AST (IU/L) | Pre-parturition | 76.80±7.75[b] | 86.45±10.42[b] | 139.95±21.42[a] | 116.85±16.84[a] | 0.07 |
| | At lambing | 73.20±7.93[ab] | 61.50±5.34[b] | 68.65±6.34[a] | 93.90±3.44[a] | 0.08 |
| | At weaning | 40.45±2.01[a] | 45.58±4.62[a] | 35.30±0.86[ab] | 39.80±1.48[a] | 0.07 |
| | Overall mean | 63.48±5.40[b] | 64.51±5.64[b] | 83.50±12.71[a] | 85.70±9.52[a] | 0.08 |
| ALT (IU/L) | Pre-parturition | 66.80±7.17 | 60.70±8.09 | 73.80±3.95 | 69.95±5.74 | 0.09 |
| | At lambing | 58.50±8.06 | 47.90±10.60 | 60.90±2.82 | 56.70±5.13 | 0.10 |
| | At weaning | 28.80±1.52 | 39.90±6.09 | 22.17±1.07 | 29.46±2.08 | 0.09 |
| | Overall mean | 51.36±5.18 | 49.50±5.02 | 52.29±5.28 | 52.03±4.60 | 0.04 |

*a, b, c, d: Means with different letters in the same row are significantly different (P<0.05).*

increased by feeding tanniniferous plants through increasing albumin fraction. Moreover, urea formed as a toxic end product from protein catabolism, and rumen microfauna can use its nitrogen for microbial protein synthesis, since the increase of its concentration may cause a toxic effect to the host animal Aldoori *et al.* (2011). Condensed tannins as a plant secondary polyphenol molecule may affect blood metabolites by either maintaining (Raghuvansi *et al.,* 2007), decreasing (Joy *et al.,* 2001), or increasing it (Mohammed *et al.,* 2004). Mahmoud (2001) found a decrease in blood globulin concentration of sheep and attributed this to the presence of a high level of tannins, which form complexes with the diet.

For the effect of physiological status, it was found that both AST and ALT in all experimental groups were at the highest concentration in plasma of ewes at pre-parturition stage indicating higher function of liver at late pregnancy. The level of these two enzymes decreased to the lowest level at the end of lactation period (at weaning lambs) that meaning alleviation of physiological stress on the liver at this time. In accordance with the present results, El-Bassiony (2013) and Shaker (2014) reported that feeding Shami goats and Barki sheep with salt tolerant plants resulted in increasing the activity of AST and ALT. This rise of ALT and AST activities might be attributed to the high tannins, oxalates, alkaloids and salt in such salt tolerant plants. Moreover, Eissa *et al.* (2016b) worked with cassava, acacia, and ammoniated wheat straw for growing Barki lambs under semi-arid conditions. They found a reduction in TP, albumin (A), globulin (G), and (A/G ratio) in animals fed salt shrubs and referred this effect back to the high content of tannins in these plants. Results in the present study are in harmony with findings of El-Saadany *et al.* (2016) who reported that concentration of urea-N and creatinine increased ($P<0.05$) in animals fed acacia compared with those fed cassava, while both groups did not differ from those fed BH and atriplex without significant differences among groups albumin (AL), globulin (GL) and AL/GL ratio in plasma as well. El-Gohary *et al.* (2017a) on Barki ewes noticed that diet contained cassava alone and that contained 10% cassava plus 10% prosopis induced significant ($P<0.05$) higher values of TP and G compared with the other treatments, but without significant differences among different treatments in A. Groups fed diets contained acacia alone and that contained 10% cassava plus 10% acacia have higher levels ($P<0.05$) of urea-N and creatinine compared to the other groups. Total protein and G of Barki lambs decreased linearly ($P<0.05$), while Urea-N and creatinine were increased linearly ($P<0.05$) as the level of diets' condensed tannin increased without significant effect on A. The present results are in agreement with Sadek *et al.* (2020).

***Economic efficiency:***

Economically, it is clear that economic efficiency (EE) presented in Table (8) was improved with cassava leaves containing diet (170.2%) relative to other tested diets. This increase is relatively attributed to the increased average daily weight gain accompanied by the low cost of feed consumed. Eissa *et al.* (2015a&b and 2016a) and Sadek *et al.* (2020) reported a valuable improvement in the economic efficiency of sheep-fed combinations of legume trees with ammoniated wheat straw. Eissa *et al.* (2016b) concluded that trees and shrubs with ammoniated wheat straw was of economic value in ration formation for growing Barki lambs helping in overcoming the feed gap during summer season that characterized by the scarcity of silage and hay and rising prices in such experimental areas.

**Table (8): Economic analysis of using tanniniferous shrubs as alternative for berseem hay in Barki ewes' diets.**

| Item | Treatment | | | |
|---|---|---|---|---|
| | Control | *Cassava Manihot esculenta* | *Acacia neloitca* | *Atriplex halimus* |
| Total feed intake (g/h/d) | 1559.68 | 1585.48 | 1498.41 | 1349.62 |
| CFM | 900.68 | 875.48 | 898.41 | 864.62 |
| BH | 662 | - | - | - |
| Cassava | - | 710 | - | - |
| Acacia | - | - | 600 | - |
| Atriplex | - | - | - | 485 |
| Price of total feed intake (LE. h/d): | | | | |
| CFM | 4.06 | 3.94 | 4.04 | 3.89 |
| BH | 1.65 | - | - | - |
| Cassava | - | 0.39 | - | - |
| Acacia | - | - | 0.33 | - |
| Atriplex | - | - | - | 0.24 |
| Total feeding cost (LE) | 5.71 | 4.33 | 4.37 | 4.13 |
| Average daily gain (g/d) | 132 | 180 | 141 | 123 |
| Price of daily gain (LE) | 8.58 | 11.70 | 9.16 | 8.00 |
| Net profit (LE./h/d) | 2.87 | 7.37 | 4.79 | 3.87 |
| Economic efficiency % | 50.26 | 170.2 | 109.61 | 93.7 |
| Relative improvement | 100 | 338.63 | 218.08 | 186.43 |

*The price was calculated due to the Egyptian local market where one-ton of CFM, Hay, cassava, acacia, atriplex & Kg BW/Lambs were 45.0, 2500, 550, 550, 500 & 65 L.E, respectively).*

*1- Net profit (L.E)= Price of daily gain - total feeding cost*

*2- Economic efficiency (EE)= Net profit / total feeding cost*

*3- Relative improvement of the control, assuming that the EE of the control=100*

## CONCLUSION

It could be concluded that cassava, acacia and atriplex leaves can be used as low price and valuable alternatives to berseem hay in diets of Barki ewes without adverse effects on their productive and reproductive performance. Cassava leaves may be the best alternative to BH followed by acacia and atriplex leaves, respectively under the present experimental conditions.

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## الآداء الإنتاجي والتناسلي للأغنام البرقي المغذاة على الكسافا ، الأكاسيا و الأتربلكس كبديل لدريس البرسيم

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صممت هذه التجربة لدراسة التقييم المقارن للمصادر العلفية التي لم تنال قسطاً وافيا من البحث بحثاً عن توفير مصادر واعدة في التغلب على محدودية الموارد العلفية في غالبية المناطق شبه الاستوائية أثناء موسم الجفاف. قد توفر هذه الموارد إمدادات كافية لنمو الحيوانات وإنتاج اللبن. تم استبدال دريس البرسيم "BH" في علف الأغنام بأوراق الكسافا أو الأكاسيا أو الأتريبليكس. تم تقسيم أربعين نعجة برقي في الثلث الأخير من الحمل زنة (43,2 ± 1,1 كجم) إلى أربعة مجموعات (10 حيوانات لكل منها). تم تغذية المجموعات إما على عليقة المقارنة ، (900 جرام من خليط الأعلاف المركزة (CFM) + 600 جرام من BH)، والعلائق المختبرة، والتي تم فيها استبدال BH بـ 600 جرام من أوراق الكسافا أو الأكاسيا أو الأتريبليكس. تم تسجيل وزن الجسم الحي للنعاج كل أسبوعين في الصباح قبل الرضاعة ، وبالنسبة للحملان ، تم اتباع طريقة وزن الرضاعة وذلك حتى الفطام. تم إجراء تجارب هضم وميزان أزوت للأغذية المختبرة. كما تم إجراء تحليل إنتاج اللبن ومكوناته وتحليل الدم. تم حساب الكفاءة الاقتصادية للمجموعات التجريبية. تم تحليل بيانات المتغيرات المدروسة إحصائياً باستخدام طريقة النموذج الخطي العام (GLM). سجلت الكسافا أعلى قيم (معنوية أقل من 0,05) لمعظم معاملات الهضم ومعاملات القيمة الغذائية بالإضافة إلى استهلاك المادة الجافة وميزان الأزوت. كانت عليقة كل من الكسافا والأكاسيا الأفضل في الحفاظ على وزن الجسم وزيادة الوزن لكل من النعاج وحملانها مقارنة بمجموعتي المقارنة والأتريبليكس. حدث تحسن معنوي (معنوية أقل من 0,01) في إنتاج اللبن لمجموعة الكسافا وقد ارتفعت (معنوية أقل من 0,05) نسب مكونات اللبن من البروتين ، الدهن ، الرماد و المواد الصلبة اللادهنية في مجموعات العلف المستبدل مقارنة بمجموعة الكونترول. كان عدد الخلايا الجسدية متماثلاً في كافة المجموعات التجريبية. كانت مجموعة الكسافا أعلى (معنوية أقل من 0,05) من البروتين الكلي في الدم وأقل نسبة ألبيومين/جلوبيولين واليوريا والكرياتينين عن مثيلتها بمجموعة المقارنة. زادت الكسافا (معنوية أقل من 0,05) من أوزان الحملان عند الفطام وزيادة الوزن اليومي مقارنة بالمعاملات الأخرى. يمكن الاستنتاج أن الكسافا والأكاسيا والأتريبليكس هي بدائل مفيدة لدريس البرسيم في علف الأغنام البرقي. مالت النعاج التي تغذت على الكسافا إلى زيادة وزن الجسم ، وإنتاج اللبن والزيادة اليومية في وزن الحملان مقارنة بتلك التي تغذت على الأكاسيا أو الأتريبلكس.