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## Effect of using Cladodes of Cactus (*Opuntia Ficus-Indica*) and *Atriplex Halimus* L. as Alternative Diet for Barbarine Pregnant Ewes: Effects on Blood Metabolites

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**Abstract**

THIS study aimed to determine whether opuntia ficus indica and atriplex halimus-based diets can serve as potential fodder for Barbarine sheep in arid and semi-arid regions. it investigated the effect of using opuntia ficus indica and atriplex halimus l. as alternative diets on blood metabolites of Barbarine pregnant ewes. thirty-six barbarine ewes in their second half of pregnancy were randomly distributed into nine groups the control group included: 0.45 kg barley and 1.8 kg barley straw (d1). ewes in the experimental groups; d2 to d6, were fed barley straw ad libitum with 100% cactus, (75% c+ 25% atriplex), (50% c + 50% atriplex), (25% c + 75% atriplex), 100% atriplex. ewes on d7, d8 and d9 were fed 100% barley straw, 100% atriplex, and 100% cactus respectively. the results revealed a significant decrease in glucose in d8 and a significant decrease in cholesterol in groups d7 and d9 but increased significantly in group 8. triglyceride decreased in d2, d3, d4, d5, d7 and d9 and increased in d8. total protein and albumin decreased slightly in groups: d1, d3, d4 and d5. blood urea and creatinine decreased significantly in groups d7 and d9. the enzymes aspartate transferase and alanine transferase showed a significant decrease in d7 and d9 and a significant increase in d8 after feeding treatment. the results also showed a significant decrease in calcium and phosphorus levels in groups: d7, d8 and d9. it could be concluded that the mixture of opuntia ficus indica and atriplex halimus can be used as alternative diets for Barbarine pregnant ewes with no adverse effects.

**Keywords:** Atriplex Halimus, Barbarine Ewes, Blood metabolites, Opuntia Ficus Indica, Pregnant Ewes.

## Introduction

Semi-arid regions comprise approximately 15% of the world's land surface and are widespread throughout Africa, Eurasia, Oceania, North, South, and Central America [1, 2, 3]. Arid and semi-arid regions suffer from extreme climate conditions such as droughts, irregular rainfall, and deteriorating soils that are all exacerbated by climate change (Food and Agriculture Organization [4,5]. Besides, these regions are home to many of small ruminants facing these difficult conditions and feed scarcity [6, 7]. One of the animal populations inhabiting these environments is the Algerian Barbarine sheep, known for its adaptability to the fragile conditions of arid and semiarid areas [8]. Despite this, the Algerian Barbarine population has suffered from size reductions in recent years [9]. The Algerian government and neighboring North African countries recognised that small ruminant herds were at risk in arid and semi-arid regions and that solutions were required. Consequently, steps were taken towards combatting feed shortage, including the growing extensive lands of cactus crops and Atriplex Halimus in these countries [10, 11]. This was because both plants were reported to be sustainable alternatives to

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feeding sheep in arid and semi-arid regions [12, 13]. A key characteristic of Cladodes of cacti is its rich supply of energy ingredients and its abundant water supply [14]. *Atriplex halimus* has a high crude protein concentration and neutral detergent of fiber [15, 16]. This study aims to determine whether Opuntia and Atriplex-based diets can serve as potential fodder for Algerian Barbarine sheep. It was hypothesised that incorporating an optimal mixture of Cladodes of *Opuntia ficus Indica* and *Atriplex Halimus* in the diet of pregnant Barbarine ewes would not adversely affect blood parameters. In the current global crisis caused by the conflict in Ukraine and the spike in droughts caused by climate change, cereals have become increasingly scarce to meet the needs of both humans and animals. Thus, the current study is timely and will have wide-ranging implications for governments, stakeholders, sheep farmers, and environmental activists. Furthermore, local steppic plants could provide a viable alternative to cereals for small ruminants, and the crisis associated with their importation would be alleviated.

## Material and Methods

### *Location*

The study was conducted on a private farm in Bayadha commune, El-Oued province, Algeria. El-Oued is located 700 km southeast of the capital: Algiers, and 80 km from Tunisian borders. The experimental animal protocol was ethically approved by the Laboratory of Agro-biotechnology and Nutrition in Semi-arid Zones, and the scientific committee of the Faculty of Natural and Life Sciences, Tiaret University, Algeria.

### *Plant Material Collection*

The plant Opuntia Ficus Indica was obtained from a private farm based in Bedjene commune, Tebessa province, Algeria. The cladodes of cactus were collected at the end of March 2022, and were stored in a cool chamber at -5 C. *Atriplex halimus* plant was obtained from the steppic zone: Zeribet El-Oued, Biskra province, Algeria. As a point of clarification, both regions belong to the same geographical area but are administered separately. The plants were collected at the beginning of April 2022, at the flowering stage. Similarly, Atriplex was stored at -5 C. Barley grains and barley straw were obtained locally.

### *Animals, diets and experiments*

Thirty-six pregnant Babarine ewes – also named Oued Souf sheep or 'Guebliya' [17]; are characterised by their fat tail [18]; common breed in El-Oued region and the east of Algeria 6-4 – years old; with an initial live body weight 57 + 4.6 kg. The first author of this paper vaccinated the ewes against prevalent diseases and parasites. The ewes were placed in individual digestibility boxes and randomly distributed into nine lots (four each). The ewes have undergone heat synchronization by vaginal sponges (FGA = 20mg (Intervet, France) and PMSG = 300 UI).

The experiment was conducted in two periods, twenty-nine days each (between 25 April- 21 June 2022), following a crossover design. The experiment was carried out in the second half of ewes' pregnancy. Figure 1 shows the experimental design adopted for the current study along with the diets fed to animals. The percentages in the figure represent the following: D1 (500g Barley grain + 1550g barley straw). D2 (5500g cactus + barley straw ad libitum), D3 (4125g cactus + 650g Atriplex+ barley straw ad libitum), D4 (2750g cactus + 1300g Atriplex + barley straw ad libitum), D5 (1375g cactus +1950g Atriplex + barley straw ad libitum), D6 (2600g Atriplex + barley straw ad libitum), D7 (1800g barley straw), D8 (2600g Atriplex), D9 (5500g cactus). The ewes were fed fresh intake and according to INRA (1988) [19].

The ewes received two diets across the two periods: D1 followed by D5; D2 followed by D4; D3 followed by D6. The researchers decided to stop the experiment for the ewes taking: D7, D8 and D9 and eliminate them from the study after the first period to avoid the potential adverse effects of the diets. It has been observed that the ewes in these experimental groups suffered from cachexia and miscarriages.

### *Chemical Analyses*

Representative samples from all plants/grains were dried in an air oven; at 103 C for 24h to determine DM; and ground on a mill with a 0.8-1mm screen. Samples were analysed for Ash by placing DM in a muffle furnace at 550 °C (AOAC 2000; method 942.05) [20]. The crude fiber was determined according to Weende (AFNOR NF V03-40 1993) [20]. Total nitrogen was determined using the method of Kjeldahl (AOAC 2005; method 954.01) [21] Crude protein was calculated by multiplying the total nitrogen by 6.25. Neutral detergent fiber (NDF) and Acid detergent fiber (ADF) were determined according to Van Soest et al. (1991) [22]. The minerals (Ca, P, K, Mg) were determined by atomic absorption spectrometry (AAS) at FATILAB2 (El Oued).

### *Blood Sample Collection*

The first researcher collected four blood samples (5ml) during both periods: two samples per period; two samples per period and diet were taken. Blood samples were collected through the jugular vein in sterile heparin tubes. The centrifugation of blood was performed at 300 rounds for 10 minutes. Plasma samples were placed in microtubes at -20 C for later analysis. Serum glucose (Glu), total cholesterol (TC), total protein (TP), triglyceride (TG), urea, creatinine (Crea), albumin (AL), Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), calcium (Ca), phosphorus (P) concentrations were analysed using commercial kits (spinreact kits, Spain), and Beckman Coulter Diagnostic for reading the results.

*Statistical Analysis*

The data obtained from the chemical analyses were handled using IBM SPSS Statistics software to calculate the mean and the standard deviation as well as one-way analysis of variance (ANOVA). The significant differences were set at P<0.05, according to Duncan (1955) [23].

## **Results and Discussion**

*Chemical Composition*

The obtained data revealed that the cladodes of opuntia have lower dry matter content (14.63%) compared to *Atriplex halimus*, barley grain and barley straw (42.43%, 92.28% and 91.24, respectively). The lower DM content in opuntia can be explained by its high level of water, which can reach 90% [24, 25]. Ash level was higher in Opuntia and Atriplex (24.69% and 19.26%, respectively) compared to barley grain and straw (3.5% and 5.4%, respectively). This result concurs with previous studies reporting that Atriplex contains high salts [26,27]. Researchers have reported that the high level of ash may urge ruminants to consume greater amounts of water, causing consequential influences on rumen functions [27, 28]. Crude protein in Opuntia was found to be within the range stated by Nefzaoui et al. [24]; from 3 to 6%, while it exhibited a higher level in Atriplex (12.87%). Earlier research reported that the high level of protein in Atriplex does not account for the nutritive value they offer as protein supplements, particularly since approximately 66% of its total nitrogen is soluble and degradable in the rumen [26, 28, 29]. CF, NDF and ADF values were lower in Opuntia (13.37%, 30.33% and 15.2%, respectively) [29] compared to Atriplex (27.12%, 50.29% and 35.43%, respectively). The NDF and ADF values reported in the current study showed that they are higher than the norms reported in other fodder shrubs by Ben Salem et al. [15], which were 30-45% and 15- 29%, respectively [28]. This can be explained by the type of soil, the age of the plant and the botanic composition. It is noticeable that Opuntia is high in Ca (6.81%) compared to Atriplex (1.44%). Our finding agrees with those reported in previous work [8].

*Blood Parameters of Energy Metabolism*

Table 2 shows the blood parameters of ewes in all the experimental groups. The values of Glucose were within the range (0.4 and 0.7g/l) as reported by Haddad [31] before the incorporation of experimental diets. This can be explained by the impact of concentrate ingested before the experiments. Despite remaining within the range, blood glucose levels showed a slight decrease in diets D1, D2, D3, D4, D5, D6 and D7 after the incorporation of experimental feeds. However, a significant decrease was observed in the glucose level of the animals fed D8, but it remained stable in animals fed D9. Plasma glucose is a critical indicator of ruminants' satisfaction with energy needs and provides a rapid assessment of animals encountering different sources of stress [25, 32, 33]. Lower glucose levels in animals fed from D1 to D7; might be due to the stress of changing diets and the status of animals in the second half of pregnancy. Higher levels of Opuntia in D9 preserved plasma glucose stability, which might be attributed to Opuntia plants' therapeutic characteristic and ability to ameliorate glycemic control by blocking the hepatic glucose output, as reported [34]. Our results are consistent with those obtained by Louacini et al. [25], who reported that feeding non-pregnant Rembi ewes 100% Opuntia did not alter blood glucose concentrations. Similar results were reported by an increasing body of research on the incorporation of different levels of cactus into goats' diets [35, 36, 37,7]. Additionally, a similar pattern was observed with cows fed cactus cladodes with different levels of concentrate [38]. However, the present result differs from those obtained by Cardoso et al. [3], who reported that incorporating different levels of spineless cactus (*Nopallea cochenillifera* Salm Dyck) in the diet of male Ines lambs increased serum glucose. Similarly, El Gindy et al. [33] found that serum glucose increased significantly in Barki lactating ewes with low levels of prickly pear cactus peels. According to Deldicque et al. [39] _ who focused on healthy males in their study_ this can be explained by the combination of Opuntia Ficus Indica fruit skin with leucine increasing the rate of glucose appearance from the intestine and liver. Other researchers have reported differences in glucose concentrations based on sampling time. For example, Rekik et al. [40] reported that plasma glucose increased two weeks before lambing and decreased two weeks after lambing in Barbarine ewes. The fluctuation in results regarding plasma glucose of sheep in the reported studies; including the current study, can be explained by the difference in Opuntia concentrate, animals' condition and characteristics.

Glucose concentrations in D3, D4, D5, and D6 _containing Atriplex combined with Opuntia and barley straw_ remained within the range. This result is in line with those obtained by Kewan [28], who reported that feeding Barki ewes fresh Atriplex and silage Atriplex combined with barley grain did not affect glucose concentrations. Similarly, previous research showed that the inclusion of Atriplex with different concentrates: Opuntia, barley grain, and barley straw; did not affect plasma glucose in lambs and ewes' diets [41, 42]. However, our results do not agree with previous work, which reported increased sanguine glucose levels in Barki ewes-fed Atriplex plants compared to those fed Barseem hay or control diets [27, 43]. On the other hand, plasma glucose decreased significantly in D8 (100% Atriplex feed) to 0.37 g/l, which might be due to a combination of several factors: the Atriplex plant is a high-protein and low-energy feed; the ewes being in late-stage pregnancy and in dire need for high-energy feed.

The concentrations of cholesterol and triglycerides were within the reference range for sheep: (0.52–0.76 g/L); (0.2-0.4 g/l), respectively, according to [44], in the control and experimental groups before incorporating experimental feed. The values of serum cholesterol remained within the range after being fed D1 (control), D2, D3, D4, D5 and D6. But animals in D7 and D9 experienced a significant decrease ($P<0.05$) with mean values of 0.39 and 0.20 g/l, respectively (Table 2), while it increased insignificantly (0.91 g/l) in D8. The values of Triglycerides after incorporating the experimental diets did not alter in the control group (D1) and D6. However, they decreased significantly ($P<0.05$) in D2, D3, D4, D5, D7, D9, and showed a significant increase ($P>0.05$) in D8. Our results regarding the decrease in cholesterol levels in diets rich in Opuntia (D9) are consistent with previous research [25, 33, 42]. This can be due to the interference of pectin in Opuntia with cholesterol synthesis by binding to bile acids [45, 33], which then reinforces cholesterol catabolism [25]. The result of the increase in cholesterol level in D8 concurs with the work of Sabry et al. [46], who studied the impact of feeding *Atriplex lentiformise ad libitum* to Barki male sheep. Unfortunately, we did not estimate fat and carbohydrate concentrations in the Atriplex plant in this study as both constituents significantly influence cholesterol levels [47]—a direction for future studies that might explain this result. It can be concluded that integrating the mixture of Atriplex and Opuntia _regardless of their differing concentrations_ did not have any adverse effects on cholesterol levels. Our results regarding the decrease in triglyceride levels in Opuntia-based diets are similar to previous research reported by Chilliard et al. [48], who incorporated the cladodes of Opuntia in Wistar mice. This could be due to the interference of pectin with the absorption of lipids [49]. However, the present results differ from other researchers who found no difference in triglyceride levels after the incorporation of Opuntia [3, 7, 37]. Similarly, the increase in triglycerides in Atriplex based diet (D8) is consistent with the results of [42, 43]. This probably could be due to poor nutrition at the critical stage of late-stage pregnancy _ which requires a balanced energy and protein-based diet _ which might have negatively affected the synthesis of triglycerides in the liver.

*Blood Parameters of Protein Metabolism*

Serum concentrations for total protein (TP) and albumin before and after treatments are summarised in Table 2. After treatment and for ewes in treatment groups: D1, D3, D4, D5; D6 for albumin only; and D7 for protein only, there was a slight but insignificant decrease in TP and albumin values. This could be attributed to the effect of time because a slight decrease was also recorded in the control group (D1). Thus, the treatments introduced in these groups did not affect serum TP and albumin. The finding of the present study on the decrease in TP and Albumin for ewes at the end of pregnancy is similar to previous work [40, 50, 51]. During pregnancy, serum protein concentrations decrease due to foetal growth and especially amino acid utilization by the fetus for protein synthesis [52, 53, 54]. There was a significant decrease in albumin levels for the treatment groups: D2, D7 (25.07 g/l and 20.17 g/l, respectively) and D9 for TP and albumin (52.57 g/l and 16.85 g/l). This finding is consistent with the results obtained by El Gindy et al. [30]. We argue that this is because of the Opuntia-based diet in these treatment groups (particularly D2 and D9). Cladodes of Opuntia are reportedly very low in protein [36], which is also congruent with what we found in the plant's chemical composition (Table 1). Besides colostrum production, mammary epithelial cells use approximately 80% of the nutrients found in blood [40, 55]. On the other hand, there was a significant increase ($P<0.05$) for treatment groups: D6 and D8 for serum TP and D8 for albumin (Table 2.). El Saadani et al. [43] observed a similar pattern of a significant increase in serum total protein between different experimental diets, including *Atriplex halimus* vs Barseem Hay. This could be attributed to Atriplex being high in crude protein (Table 1). Regarding albumin, El Gohary et al. [56] reported a significant increase in plasma albumin in Barki lambs fed a mixture of Acacia and *Atriplex nummularia*. The present result could be explained by albumin coping with salt stress and regulating the body's fluid balance [57]. However, our findings differ from those obtained by Badawi et al. [58], who reported that the Barki lambs fed *Atriplex nummularia* indicated a lower Al/Gl ratio. In addition, Sabry et al. [46] reported that

Barki ram fed different *Atriplex lentiformis* rations showed a significant decrease in TP in all groups. To sum up, a balanced blend of Opuntia and Atriplex did not affect blood parameters, while an extreme diet containing any of these plants exhibited adverse effects.

Urea and creatinine concentrations showed no difference after the treatment in groups: D3, D4, D5, D6; D7 in urea only; and D2 in creatinine only. Blood urea and creatinine in these groups were similar to the control group (D1), indicating normal renal functions in animals fed on a mixture of Atriplex and Opuntia. This concurs with the results of [42]. Blood urea concentrations decreased significantly in animals fed the highest Opuntia (D2 and D9), and creatinine decreased significantly in animals fed the barley straw and Opuntia (D2 and D9, respectively). Regarding blood urea, our results are in the same direction as previous research [3, 25, 49]. This might relate to Opuntia's low crude protein [59]. Also, urea blood concentrations decreased significantly in the Atriplex-based diet (D8) with a mean of 0.15 g/l (Table 2). This result aligns with [60], who reported increased blood urea after feeding Atriplex to Barki lambs. The current result reflects a low CP intake [61]. On the other hand, creatinine concentrations decreased significantly in D7, D8 and D9 with means of 6.22 g/l, 5.20 g/l and 5.09 g/l, respectively. Two possible interpretations of this result might be: the negative effect of the less-balanced diets in D7, D8 and D9 compared to the control and the rest of the experimental diets; and the complications of the end of pregnancy in sheep. However, our results differ from others who found no difference in creatinine levels in goats fed spineless cactus [3]. Fayed et al. [60] reported increased creatinine concentrations in Barki lambs fed on a mixture of Alfafa and Atriplex.

*Enzyme Metabolism Parameters*

Enzymes Aspartate Transferase (AST) and Alanine Transferase (ALT) are important indicators of liver functions. AST and ALT concentrations were not affected in treatment groups: D2, D3, D4, D5; D6 for ALT only, compared to the control group (D1) (Table. 2). The obtained results agree with previous work that incorporated cacti in diets of lambs and lactating ewes [3, 33, 62]. Also, similar findings were obtained by Alhanafi et al. [42] who reported that a mixture of Atriplex and Opuntia did not alter the levels of AST and ALT. Thus, these experimental treatments; which included a mixture of Atriplex and Opuntia; have no adverse effects on the hepatic tissue.

Concentrations of AST and ALT decreased significantly after the treatment in groups: D7 and D9 recorded 53.5 and 42.75 IU / L, respectively, while the corresponding of ALT showed 5.5 and 4.0 IU, respectively. This can be attributed to the non-balanced diet in both groups and the complications of the end of pregnancy. However, AST and ALT concentrations increased significantly ($P<0.05$) after the treatment in D8 and D6 for AST only. Similar results were reported by Sabri et al. [46] and Fayed et al. [60], who reported that feeding Atriplex or a mixture of Atriplex and Alfafa increased serum enzyme AST in Barki lambs than that fed a control diet. Eissa et al. [63] also reported a significant increase in the two enzymes in Barki pregnant ewes fed on Accasia, Cassava and Atriplex. This can be attributed to the high tannins and salt in Atriplex

*Blood Parameters of Mineral Metabolism*

Regarding blood mineral concentrations, there were no significant changes in treatment groups: D1, D2, D3, D4, D5 and D6. This aligns with previous research [40, 42]. Plasma calcium concentrations increased numerically but remained within the range (90-110) according to Klashing et al. [64] in the following experimental groups: D2, D4, D5 and D6 (Table. 2). The slight increase might be due to the high concentration of calcium in the Opuntia plant, as reported in this study: 6.81% of DM and as was previously reported [8]. It is also noteworthy that earlier researchers have reported that high levels of Ca in blood composition do not reflect its status due to oxalates in the chemical composition of Opuntia [65]. Plasma phosphorus (P) decreased numerically but insignificantly in the control group and the following experimental group: D2, D3, D4, D5 and D6. This was similar to the findings of [37]. Ca and P decreased significantly in experimental groups: D7, D8 and D9. This might be explained by the unbalanced diet in these groups and the critical period of late pregnancy.

## **Conclusion**

This study pinpoints that a measured mixture of Opuntia *Ficus Indica* and *Atriplex Halimus* with barley straw *ad libitum* (namely D2, D3, D4, D5 and D6) can be introduced to pregnant ewes in semi-arid regions, decreasing feeding costs without any adverse effects on health and pregnancy. Besides, a barley straw-alone, Atriplex-alone, or Cactus-alone diet (D7, D8, and D9) risks pregnant ewes' health and body functions, including kidney and liver. Therefore, if mixed at an optimal level, Atriplex and Opuntia plants can be an economical alternative to concentrate diets typically used by sheep keepers in Algeria and similar arid and semi-arid regions.

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*Declaration of Conflict of Interest*

The authors declare that there is no conflict of interest.

*Ethical of approval*

No experiments were conducted on animals before getting the ethical approval of the laboratory of Agro-biotechnology and Nutrition in Semi-arid

Zones, and scientific committee at the Faculty of Natural and Life Sciences, Tiaret University, Algeria (ethics approval number; 21/09/2021).

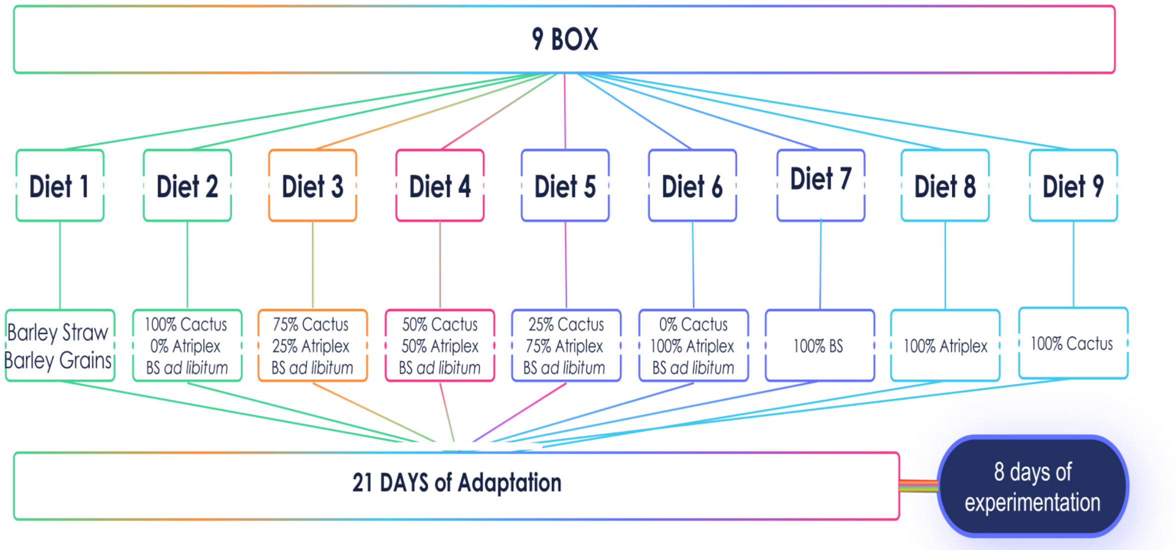


**Fig. 1. Experimental design and diets.**

**TABLE 1. The Chemical Composition of the Experimental Feeds (in % DM)**

| | *Opuntia Ficus Indica* | *Atriplex Halimus* | **Barley grain** | **Barley straw** |
|---|---|---|---|---|
| DM | 14.63±1.5 | 42.43±1.51 | 92.28±1.27 | 91.24±0.41 |
| OM | 75.31±1.1 | 80.74±1.3 | 96.5±0.15 | 94.6±0.7 |
| Ash | 24.69±0.9 | 19.26±1.17 | 3.5±0.4 | 5.4±0.23 |
| CP | 4.91±1.4 | 12.87±1.2 | 9.8±0.7 | 3.2±0.81 |
| CF | 13.37±1.35 | 27.21±1.08 | 6.83±1.02 | 48.07±1.75 |
| NDF | 30.33±2.9 | 50.29±0.85 | 25.9±0.8 | 67.8±2.6 |
| ADF | 15.2±1.9 | 35.43±1.34 | 6.8±0.57 | 45.4±3.59 |
| Ca | 6.81±0.57 | 1.44±0.6 | 0.1±0.28 | 0.2±0.37 |
| P | 0.35±0.66 | 0.25±0.2 | 0.4±0.76 | 0.12±0.9 |
| Mg | 0.49±0.12 | 0.98±0.56 | 0.2±0.14 | 0.11±0.48 |
| K | 2.91±0.21 | 0.38±0.13 | 0.6±0.93 | 1.20±0.11 |

Each value is the mean of four observations. ±: Standard deviation. DM: dry matter, OM: organic matter, CP: crude proteins, CF: crude fiber. NDF: neutral detergent fiber. ADF: acid detergent fiber. Ca: calcium. P: phosphorus. Mg: Magnesium. K: Potassium.

**TABLE 2. Blood metabolites Concentration for Ewes fed Cactus and Atriplex.**

| | | D1 | D2 | D3 | D4 | D5 | D6 | 7D | D8 | D9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Glu | before | $0.51^{+}- 0.01^{a}$ | $0.54^{+}-0.03^{a}$ | $0.54+-0.04^{a}$ | $0.52+-0.03^{a}$ | $0.53+-0.03^{a}$ | $0.55+-0.03^{a}$ | $0.55+-0.05^{a}$ | $0.53+-0.03^{a}$ | $0.55+-0.05^{a}$ |
| | After | $0.42^{+}-0.02^{b}$ | $0.45^{+}-0.04^{b}$ | $0.42^{+}-0.05^{b}$ | $0.44^{+}-0.05^{b}$ | $0.43^{+}-0.06^{b}$ | $0.44^{+}-0.04^{b}$ | $0.44^{+}-0.05^{b}$ | $0.37^{+}-0.03^{c}$ | $0.53^{+}-0.05^{a}$ |
| TC | before | $0.73^{+}-0.08^{a}$ | $0.83^{+}-0.13^{a}$ | $0.62^{+}-0.06^{a}$ | $0.71^{+}-0.13^{a}$ | $0.73^{+}-0.07^{a}$ | $0.74^{+}-0.17^{a}$ | $0.69^{+}-0.09^{a}$ | $0.59^{+}-0.11^{a}$ | $0.74^{+}-0.12^{a}$ |
| | After | $0.67^{+}-0.15^{a}$ | $0.70^{+}-0.13^{a}$ | $0.60^{+}-0.08^{b}$ | $0.61^{+}-0.10^{b}$ | $0.63^{+}-0.13^{a}$ | $0.73^{+}-0.13^{a}$ | $0.39^{+}-0.05^{b}$ | $0.91^{+}-0.08^{a}$ | $0.20^{+}-0.08^{c}$ |
| TG | before | $0.30^{+}-0.73^{a}$ | $0.32^{+}-0.75^{a}$ | $0.29^{+}-0.79^{a}$ | $0.30^{+}-0.78^{a}$ | $0.32^{+}-0.92^{a}$ | $0.30^{+}-0.79^{a}$ | $0.35^{+}-0.85^{a}$ | $0.35^{+}-0.83^{a}$ | $0.34^{+}-0.38^{a}$ |
| | After | $0.30^{+}-0.08^{b}$ | $0.10^{+}-0.02^{c}$ | $0.08^{+}-0.02^{c}$ | $0.13^{+}-0.03^{c}$ | $0.13^{+}-0.02^{c}$ | $0.27^{+}-0.03^{b}$ | $0.14^{+}-0.04^{c}$ | $0.75^{+}-0.04^{a}$ | $0.03^{+}-0.01^{c}$ |
| AL | before | $34.33^{+}-2.98^{a}$ | $33.21^{+}-4.33^{a}$ | $32.01^{+}-5.11^{a}$ | $32.35^{+}-4.64^{a}$ | $33.10^{+}-3.62^{a}$ | $33.58^{+}-3.35^{a}$ | $34.57+-3.56^{a}$ | $31.07^{+}-3.12^{a}$ | $34.57^{+}-3.56^{a}$ |
| | After | $32.62^{+}-4.07^{b}$ | $25.07^{+}-5.21^{c}$ | $31.15^{+}-5.61^{b}$ | $30.83^{+}-5.18^{b}$ | $32.12^{+}-4.49^{b}$ | $35.76^{+}-4.27^{b}$ | $20.17^{+}-1.12^{c}$ | $56.25^{+}-5.42^{a}$ | $16.85^{+}-3.62^{c}$ |
| TP | before | $67.87^{+}-5.86^{a}$ | $76.8^{+}-8.79^{a}$ | $68.15^{+}-5.5^{a}$ | $70.3^{+}-8.35^{a}$ | $68.47^{+}-5.53^{a}$ | $72.32^{+}-8.77^{a}$ | $78.75^{+}-7.22^{a}$ | $70.02^{+}-7.31^{a}$ | $78.12^{+}-5.84^{a}$ |
| | After | $64.36^{+}-5.82^{b}$ | $70.23^{+}-7.97^{a}$ | $65.20^{+}-3.93^{b}$ | $69.18^{+}-6.70^{b}$ | $66.50^{+}-6.05^{b}$ | $80.65^{+}-8.11^{ab}$ | $63.85^{+}-10.63^{b}$ | $86.85^{+}-4.38^{a}$ | $52.57^{+}-1.43^{b}$ |
| Urea | before | $0.35^{+}-0.06^{a}$ | $0.35^{+}-0.06^{a}$ | $0.35^{+}-0.06^{a}$ | $0.35^{+}-0.05^{a}$ | $0.35^{+}-0.05^{a}$ | $0.35^{+}-0.05^{a}$ | $0.37^{+}-0.06^{a}$ | $0.35^{+}-0.07^{a}$ | $0.37^{+}-0.05^{a}$ |
| | After | $0.34^{+}-0.07^{a}$ | $0.17^{+}-0.03^{ab}$ | $0.27^{+}-0.10^{a}$ | $0.30^{+}-0.06^{a}$ | $0.28^{+}-0.08^{a}$ | $0.26^{+}-0.09^{a}$ | $0.28^{+}-0.08^{a}$ | $0.15^{+}-0.02^{ab}$ | $0.04^{+}-0.03^{b}$ |
| Crea | Before | $11.97^{+}-1.13^{a}$ | $11.45^{+}-2.25^{a}$ | $10.30^{+}-2.02^{a}$ | $10.09^{+}-2.44^{a}$ | $10.31^{+}-2.44^{a}$ | $9.65^{+}-1.72^{a}$ | $12.42^{+}-2.41^{a}$ | $11.08^{+}-1.48^{a}$ | $10.65^{+}-2.49^{a}$ |
| | After | $11.15^{+}-1.83^{ab}$ | $13.10^{+}-2.56^{a}$ | $11.33^{+}-1.86^{a}$ | $11.83^{+}-2.31^{a}$ | $11.48^{+}-1.94^{a}$ | $11.02^{+}-2.40^{ab}$ | $6.22^{+}-0.79^{b}$ | $5.20^{+}-0.86^{b}$ | $5.09^{+}-1.42^{b}$ |
| AST | Before | $88.25^{+}-11.04^{a}$ | $101^{+}-12.36^{a}$ | $71.12^{+}-18.37^{a}$ | $79.39^{+}-17.98^{a}$ | $74^{+}-17.09^{a}$ | $85.37^{+}-17.47^{a}$ | $74.5^{+}-10.40^{a}$ | $77^{+}-11.16^{a}$ | $78^{+}-13.68^{a}$ |
| | After | $78.62^{+}-7.28^{bc}$ | $70.5^{+}-7.46^{bc}$ | $75^{+}-15.74^{bc}$ | $77.62^{+}-2.32^{bc}$ | $102.37^{+}-8.80^{b}$ | $134.5^{+}-30.31^{ab}$ | $53.5^{+}-5.32^{c}$ | $172^{+}-14^{a}$ | $42.75^{+}-6.02^{c}$ |
| ALT | Before | $10.62^{+}-3.24^{a}$ | $11.37^{+}-3.7^{a}$ | $8.75^{+}-2.12^{a}$ | $12.62^{+}-7.2^{a}$ | $9.62^{+}-2.66^{a}$ | $9.12^{+}-2.85^{a}$ | $9.5^{+}-2.08^{a}$ | $11^{+}-2.16^{a}$ | $10.5^{+}-1.29^{a}$ |
| | After | $10.37^{+}-2.72^{b}$ | $7.62^{+}-2.82^{b}$ | $9.62^{+}-3.24^{b}$ | $12.37^{+}-6.13^{b}$ | $13.75^{+}-4.83^{ab}$ | $13.87^{+}-4.29^{ab}$ | $5.5^{+}-1.29^{b}$ | $23.25^{+}-3.3^{a}$ | $4^{+}-0.81^{b}$ |
| Ca | Before | $104.12^{+}-6.17^{a}$ | $96.96^{+}-12.47^{a}$ | $94.86^{+}-10.44^{a}$ | $102.67^{+}-12.10^{a}$ | $95.26^{+}-15.45^{a}$ | $93.63^{+}$-12.60a | $95.2^{+}-13.77^{a}$ | $103.75^{+}-12.81^{a}$ | $97.22^{+}-19.66^{a}$ |
| | After | $100.15^{+}-10.59^{ab}$ | $98.21^{+}-12.3^{ab}$ | $93.93^{+}-14.43^{ab}$ | $103.07^{+}-12.58^{a}$ | $502.02^{+}-6.12^{a}$ | $105.12^{+}-8.65^{a}$ | $63.17^{+}-4.91^{b}$ | $74.2^{+}-11.03^{b}$ | $61.2^{+}-5.63^{b}$ |
| P | Before | $73.75^{+}-16.17^{a}$ | $76.68^{+}-18.38^{a}$ | $75.38^{+}-14.69^{a}$ | $76.89^{+}-15.15^{a}$ | $73.98^{+}-15.70^{a}$ | $65.50^{+}-12.21^{a}$ | $60.06^{+}-11.60^{a}$ | $69^{+}-10.31^{a}$ | $61.26^{+}-15.09^{a}$ |
| | After | $70.69^{+}-15.26^{ab}$ | $71.92^{+}-12.66^{ab}$ | $78.21^{+}-18.43^{a}$ | $75.36^{+}-13.44^{ab}$ | $68.93^{+}-16.39^{ab}$ | $63.69^{+}-12.46^{ab}$ | $42.15^{+}-7.05^{b}$ | $34.38^{+}-9.29^{b}$ | $28.42^{+}-4.5^{b}$ |

a, b, c: Means with different letters in the same raw are significantly different ($P<0.05$). Serum glucose (Glu), total cholesterol (TC), total protein (TP), triglyceride (TG), urea, creatinine (Crea), albumin (AL), Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), calcium (Ca), phosphorus (P)

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## تأثير نبات الصبار (أوبونتيا فيكوس إنديكا) والقطف (أتريبلكس هاليموس إل) كعلف بديل لنعاج البربرين الحوامل على الايض الدموي

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**الملخص**

تهدف هذه الدراسة إلى تحديد إمكانية استخدام الصبار الهندي (Opuntia Ficus Indica) والقطف (Atriplex Halimus) كعلف بديل لغنم سلالة البربرين في المناطق الجافة وشبه الجافة. حيث تطرقنا إلى دراسة تأثير إضافة الصبار الهندي والقطف على الايض الدموي لمجموعة نعاج حوامل من سلالة البربرين كبديل غذائي في ظل تأثيرات تغير المناخ. تم انتقاء ستة وثلاثون نعجة في النصف الثاني من الحمل وتقسيمهم بشكل عشوائي إلى تسع مجموعات. تضمنت تغذية المجموعة الضابطة 0,45 كغ من الشعير و1,8 كغ من تبن الشعير (D1) .تم تغذية الأغنام في المجموعات التجريبية من D2 إلى D6 بتبن الشعير حسب الرغبة مع 100% صبار، (75%صبار + 25% قطف)، (50% صبار + 50% قطف)، (25% صبار + 75% قطف)، 100% قطف. تم تغذية النعاج في المجموعات D7 و D8و D9 بتبن الشعير 100%، وقطف 100%، وصبار 100% على التوالي. أظهرت النتائج انخفاضًا ملحوظًا في الجلوكوز في المجموعة D8 وانخفاضًا ملحوظًا في الكوليسترول في المجموعتين D7 و D9 ولكن زاد بشكل ملحوظ في المجموعة D8
انخفض الدهن الثلاثي في المجموعات D2 و D3 و D4 و D5 و D7 و D9 وارتفع فيD8 ، كما انخفض البروتين الكلي والألبومين بشكل طفيف في المجموعات D1 و D3 و D4 و .D5 انخفض اليوريا والكرياتينين في الدم بشكل ملحوظ في المجموعتين D7 و D9 أظهر إنزيمي الأسبارتات الأمينوترانسفيراز والألانين الأمينوترانسفيراز انخفاضًا ملحوظًا في المجموعتين D7 و D9 وزيادة ملحوظة في.D8

كما أظهرت النتائج أيضًا انخفاضًا ملحوظًا في مستويات الكالسيوم والفوسفور في المجموعات D7 و D8 و D9 لذلك، تم استنتاج أن الخليط الأمثل من الصبار الهندي والقطف مع تبن الشعير حسب الرغبة في المجموعات D2 و D3 و D4و D5 و D6 سيكون بديلاً غذائياً مناسبًا للنعاج الحوامل بدون آثار جانبية على صحتها.

**الكلمات الدالة** :القطف، الصبار الهندي، سلالة البربرين، مؤشرات الأيض الدموي، النعاج الحوامل.