

**EFFECT OF FEEDING SPINELESS CACTUS (*Opuntia ficus*) ON  
GROWTH PERFORMANCE OF MADGYAL LAMBS**

**T H E S I S**

Submitted

In partial fulfillment of requirements for the Degree of

**MASTER OF VETERINARY SCIENCE  
IN  
LIVESTOCK PRODUCTION MANAGEMENT**

**BY**

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**2024**

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I hereby declare that the experimental research work and interpretation of the thesis entitled **EFFECT OF FEEDING SPINELESS CACTUS (*Opuntia ficus*) ON GROWTH PERFORMANCE OF MADGYAL LAMBS** or part thereof has not been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis/publication of any University or scientific organization. The sources of materials used and all assistance received during the course of investigation have been duly acknowledged.

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Mr. PAWAR AKSHAYKUMAR ASHOKRAO has satisfactorily prosecuted his course of research for a period of not less than one semester and that the thesis entitled **EFFECT OF FEEDING SPINELESS CACTUS (*Opuntia ficus*) ON GROWTH PERFORMANCE OF MADGYAL LAMBS** submitted by him is the result of research work is sufficient to warrant its presentation to the examination in the subject of **LIVESTOCK PRODUCTION MANAGEMENT** for the award of **MASTER OF VETERINARY SCIENCE** degree by the Maharashtra Animal and Fishery Sciences University, Nagpur.

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*Dedicated to  
My Family....*

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**Place: Shirwal**

**(Pawar Akshaykumar Ashokrao)**

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SR.NO.	ABBREVIATIONS	EXPLANATION
1.	%	Percentage
2.	µl	Microliter
3.	ADG	Average Daily Gain
4.	ALT	Alanine Transaminase
5.	AOAC	Association of Official Analytical Chemists
6.	AST	Aspartate Transaminase
7.	BIS	Bureau of Indian Standards
8.	CF	Crude Fiber
9.	CP	Crude Protein
10.	dl	Deciliter
11.	DM	Dry Matter
12.	DMB	Dry Matter Basis
13.	DMI	Dry Matter Intake
14.	EE	Ether Extract
15.	<i>et al.</i>	<i>et alia</i>
16.	Fig	Figure
17.	gm or g	Gram
18.	Hb	Haemoglobin
19.	ICAR	Indian Council of Agricultural Research
20.	IU	International Unit
22.	Kg	Kilogram

23.	L	Litter
24.	M.S	Maharashtra State
25.	mg	Microgram
26.	ml	Milliliter
27.	c <sup>0</sup>	Degree celcus
28.	NFE	Nitrogen Free Extract
30.	ng	Nanogram
31.	No	Number
32.	NS	Non-Significant
33.	OM	Organic Matter
34.	P value	Probability Value
35.	PCV	Packed Cell Volume
36.	Rs	Rupee
37.	S	Significant
38.	SE	Standard Error
39.	SGOT	Serum Glutamic Oxaloacetic Transaminase
40.	SGPT	Serum Glutamic Pyruvic Transaminase
41.	ANNOVA	Analysis of variance
43.	TEC	Total Erythrocyte Count
44.	TLC	Total Leucocyte Count

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# *Introduction*

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## CHAPTER I

### INTRODUCTION

In India, there is a deficit of 43% of concentrate feed ingredients, 35.5% of green fodders and 10.91% of dry roughages (IGFRI, Vision 2050). The government labels 30% of India's landmass as wasteland. Against the backdrop of ongoing climate change, frequent and long droughts, land degradation, deforestation and green fodder scarcity. The problem is even worse in semi-arid and arid regions where erratic and unreliable rainfall results in seasonal feed supply variations. Under such conditions, there is a need to look for locally available alternative or optional feed resources to make animals survive in such critical stages of shortage in feed supply (Firew, 2007). The adequate attention was not given to fodder crops due to increasing pressure on land for the production of oil seeds, food grains and pulses which led to a shortage of feed and fodder. The area of permanent pasture and grazing lands is about 10.26 million hectares and this is gradually decreasing whereas, the area under fodder cultivation is only about 4 percent of the cropping area. Therefore Spineless Cactus (*Opuntia ficus*) may be a potential alternative fodder for livestock in arid and semiarid regions. (Russell and Felker, 1987).

The Spineless cactus is a fast-growing xerophytic plant well adapted to arid and semi-arid regions. It remains green even during summer and can be used as a feed during scarcity or dry months of the year. Spineless cactus belongs to the family *Cactaceae* including about 130 genera. It is highly resilient and has high water-using efficiency and it can grow in poor and degraded lands where other plants cannot grow. Spineless Cactus is vegetatively propagated and cladodes are used for propagation. Spineless Cactus pear has the advantage of being a source of water for animals, particularly during the dry season. It tolerates poor soil conditions and produces high biomass yield (Russell and Felker, 1987). The most important characteristic of Spineless cactus is its huge potential for producing large quantities of green, succulent fodder, under relatively unfavorable conditions (De Kock, 1980). Spineless cactus can convert water 4-5 times more efficiently to dry matter (DM) than the most efficient grasses (Russell and Felker,

1987). There are other attributes such as the ability to remain succulent during drought and produce forage, fruit, and other useful products as well as its capacity to prevent long-term degradation of ecologically weak environments have increased the importance of cacti in arid and semi-arid regions. Ruminants living in these arid and semi-arid regions can make efficient use of non-conventional feed resources like Spineless cactus (*Opuntia ficus*). Different parts of edible cacti have been shown to have antioxidant, anti-inflammatory, anti-diabetic and anti-cholesterogenic activities (Kauthale *et al.*, 2017). Hence, an attempt should be made to cover aspects like its production, potential as ruminant feed and high water content encompassing its effect of inclusion in the ration on feed intake, nutrient utilization and production performance.

In Sustainable fodder production systems, cactus cultivation have gained a unique place in drylands. Water scarcity and rangeland degradation are threatening livestock production in dry areas. Adapted perennial species such as cacti offer opportunities for increasing fodder availability in drylands. Spineless cactus has high production of biomass from 20 tonnes dry matter (DM)/ha/year to 200 tonnes DM/ha/year. Being rich in water, it represents a cost-effective option for water provision to livestock in arid and semi-arid regions. With such a high biomass yield, it is possible to produce sufficient forage to sustain 10 to 15 sheep per year. A small intensively cultivated Spineless cactus plantation can produce sufficient fodder, decreasing the pressure on overstocked rangelands. The Spineless cactus has a very low water footprint, approximately 250 liters/kg DM. Besides water, Spineless cactus (*Opuntia ficus*) cladodes are high in sugars, ash and vitamins A and C, but are low in crude protein (CP; 3–5%) and most of the nitrogen is present as non-protein nitrogen. The CP content decreases as cactus cladodes age hence older the cladode, the lower its CP content. The Spineless cactus cladodes are highly palatable and it has a higher Ca:P ratio. The nutritive value of cladodes varies with species and type of cultivation. It also varies according to season, agronomic condition, soil, rainfall, and fertilization, among others. One to three-year-old Spineless cactus cladodes are high in water during winter and spring (83–90%) and low in summer (75–82%); The younger the cladode has a higher water content than older cladode. The inclusion of chemical

fertilizers (ammonite and superphosphate) while cultivation has increased the CP content of cladodes from 45 to 105 g/kg DM. Selective breeding among themselves has also been used to increase the CP content of cladodes to 10%. The carbohydrate content is approximately 60% and  $\beta$ -carotene level is approximately 0.65 mg/100 g DM and the mucilage is high (6–13 g/kg fresh material). Mucilage concentration in summer is almost twice that in winter. It reduces salivation in ruminants, which prevents a rapid decrease in rumen pH and prevents acidosis. Other soluble carbohydrate-rich feedstuffs, such as molasses, cause acidosis in the ruminants because they are low in mucilage or they don't have mucilage. The neutral detergent fiber content of Spineless cactus cladodes varies from 18 to 30% and Acid detergent fiber and acid detergent lignin contents are from 12–20% and 1.5– 4.0% respectively. The use of cladodes as a feed can solve the problem of livestock water drinking but concern should be given to their high water content. Ruminants shouldn't consume large quantities of cladodes, which may lead to diarrhoea as it has a quantity of fiber. It is therefore recommended to associate a fibrous feedstuff. Also, since cladodes are low in nitrogen and high in energy, it is vital to supplement them with sources rich in nitrogen. Good productivity response has been observed because of the inclusion of nitrogenous substances with cladodes in ruminant diets.

India is an agriculture-dominated country in the world and small marginal farmers account for roughly 80 to 84% of the overall agricultural population in India (Gautam *et al.*, 2016). Also, India has the highest livestock population in the world having a very high demand for fodder. In developing countries like India, there is a big imbalance between supply and demand for livestock feed. The country has a very high green fodder deficit. Replacing costlier protein supplements with readily available, inexpensive, and high-quality feed allows farmers to increase income while maintaining animal health. Increasing livestock rearing techniques among farmers necessitates the use of nutrient-dense, low-cost feed supplements to reduce feed costs and boost animal production efficiency.

“Animal husbandry” is an integral part of the agricultural sector. People began domesticating animals after learning about their significance as a source of milk, meat and agricultural draught power, among other things. Since, 700 B.C.,

sheep had been domesticated by humans for meat production. They can be found on all continents and in far-flung corners of the globe. The sheep is one of the kindest creatures and according to the country's 20<sup>th</sup> livestock census, the total livestock population was 535.78 million in 2019, an increase of 4.6% from the previous census in 2012. In the year 2019, the country's sheep population was 74.26 million, a rise of 14.1% over the previous Livestock census. Maharashtra state had a total goat population of 2.7 million, a rise of about 3.87 % from the previous livestock census. Goats account for around 13.8% of the total livestock population in the world. (Source: 2019- 20<sup>th</sup> Livestock Census).

Small ruminants are of very economic importance to small land-holder farmers and especially women. The total income share of small ruminants tends to be inversely related to the size of land-holding, suggesting that small ruminants are of particular importance for landless people especially women. In some cultural settings, women are often not entitled to own land and since agriculture (crop production) provides only seasonal employment, rearing small ruminants would provide employment and income as a subsidiary occupation. Livestock are often regarded as producers of milk and meat, income generators, and reservoirs of wealth.

The Madgyal sheep derived its name from the Madgyal village from Jat tahsil of district Sangali, in Maharashtra. It has been evolved from selective breeding from local breeds. The sheep is known for mutton and coarse wool production due to its large body size and sturdy. The color is mainly white with brown patches on the body and a brown ring around the eyes. The ewes and rams are polled having Roman nose with black eyelids and long drooping ears. Madgyal sheep are much superior in respect of body gain, prolificacy, early maturity and adult weight in comparison to Deccani, a sheep breed from the same breeding tract. Madgyal rams are becoming increasingly popular for the upgradation of local flocks. On the other hand, Madgyal was found to be more susceptible to diseases and less capable of coping with stress. Madgyal sheep are primarily maintained on grazing. Flocks are grazed in the open for 8-10 hours daily. The distance traveled from the paddock to the pastoral area for grazing varies from 3-10 km/day. In pastoral areas, sheep normally graze within a radius

of about 3 km of a watering point. Water is provided 2-3 times a day depending upon availability of water source and weather conditions. The sheep flocks are migratory. Shepherds remain on temporary migration for 6-8 months (November-June). Migration is restricted mostly within the state in the adjoining districts. Shepherds migrate after celebrating Deepawali at home and return after the arrival of monsoon rains.

On the above important breed, the following objectives were studied:

### **OBJECTIVES**

1. To study the growth performance of Madgyal Lambs by supplementation of feeding Spineless Cactus (*Opuntia ficus*).
2. To study the effect of supplementation of Spineless Cactus (*Opuntia ficus*) on Haematological and Biochemical parameters.
3. To study the economics of Spineless Cactus (*Opuntia ficus*) feeding on Madgyal lambs.

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*Review of Literature*

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## CHAPTER II

### REVIEW OF LITERATURE

#### 2.1 Composition of Spineless Cactus (*Opuntia ficus*)

Nobel (1983) conducted a study to examine the nutrient levels of ten cactus species for years he stated that the CP content at 1st, 2nd, 3rd and 4th year was 11.5, 5.74, 5.50 and 5.65 percent respectively. Compared to mature 12-year-old cladodes, the 2-year-old cladodes had substantially higher nitrogen, potassium and manganese, but lower in sodium, calcium and iron. This was related to age and higher metabolic activity of young cladodes. Therefore, it proves that younger cactus cladodes have more nutrients than older cladodes.

Retamal *et al.*, (1987) experimented with different types of prickly pear of *opuntia ficus-indica* in different stages like vegetative, flowering, and fruit-bearing, To study moisture content, ether extract, crude fiber, sugar analysis which found that the highest values of moisture content, free reducing sugars, starch and protein were detected during spring (92.5 %, 103 mg/ g, 226 mg/ g and 14.8 %, respectively) in young cladodes, while ash content, ether extract and 11 calorific contents presented the highest values at the end of the season (29.8 percent, 36 mg/ g and 14.5 MJ/ kg, respectively).

Gregory and Felker., (1992) carried experiment to study the composition of *opuntia ficus-indica*, he found that the CP content decreased as the age of spineless cactus increased and the total carbohydrate content increased considerably during cladode growth. The season has a profound impact on the chemical composition of spineless cactus.

Ben Salem *et al.*, (1996) reported that cactus to be rich in readily available carbohydrates, which could serve as a source of energy for animals. Due to this, it could be used as supplement for animals on poor-quality roughages. The combination of cactus with cereal straw could be a nutritionally satisfactory solution for maintaining small ruminants in arid zones.

Sirohi *et al.*, (1997) conducted an experiment on 18 adult rams to assess the effect of cactus they made three groups as (i) *Cenchrus ciliaris* hay to appetite plus 200 g concentrate (G<sub>1</sub>), (ii) chopped cactus and *Cenchrus ciliaris* (G<sub>2</sub>), and (iii) chopped cactus and *Sorghum helepense* (G<sub>3</sub>) in a cafeteria system. They reported that the chemical composition of spineless cactus was 12.5, 9.20, 20.2, 38.5 and 18.9 percent for DM, CP, Ash, NDF and ADF respectively and gross energy 42 M Cal/kg DM, soluble carbohydrate of cactus was over 251 g/kg DM and the CP content was 83 g/kg DM. Also, water intake has been decreased of cactus-fed rams. While cactus-fed rams have decreased the weight.

Salem *et al.*, (2002) reported that cactus cladodes contained 17.7% DM. The concentration of OM, TDN, CP, NDF, ADF, ADL, Ca, P, Na, K and Mg were 76.2, 65.0, 4.6, 33.8, 16.8, 5.2, 5.21, 0.1, 0.06, 2.6 and 1.09%, respectively. The levels of Cu, Fe, Mn and Zn were 6.5, 170.8, 248.9 and 31.0 ppm, respectively.

Misra *et al.*, (2006) experimented with CSWRI, Avikanagar on 21 Malpura breed rams of 3 to 4 years old. The diet consisted of *Cenchrus (C. ciliaris)* hay and chopped (5–8 cm) *opuntia* cladodes offered ad libitum for 45 days. They have found that the values of DM, CP, Ash, NDF and ADF were 21.8, 12.6, 17.2, 46.6 and 39.3 % respectively and gross energy of 3.9 M Cal/kg DM. Also, it was found that sheep generally ate them before roughages and cactus is palatable.

In Ethiopia Gebremariam *et al.*, (2006) reported that cactus contain water content of 880 g/kg fresh weight basis. Further, the cactus cladodes had high ash (mineral content), especially calcium (45 g/kg DM). whereas, the phosphorus concentration was 2.6 g/kg DM and the ratio of calcium to phosphorus 17:1.

Batista *et al.*, (2009) The study was conducted to determine chemical composition and ruminal nutrient degradability of eight spineless cactus cultivators grown in northeastern Brazil. Results showed that neutral detergent fiber was similar for all cultivators and averaged 249 g/kg ± 7.3 SEM. Acid detergent fiber ranged between 148 g/kg and 207 g/kg with some significant

differences between cultivars. Starch and water-soluble carbohydrates were similar for all cultivars and averaged 198 g/kg±6.3 SEM and 155 g/kg±9.0 SEM, respectively. Protein content was less than 50 g/kg with some significant differences between cultivars. Calcium was the mineral with the highest concentration followed by potassium and magnesium with no differences between cultivars. Effective ruminal degradability of dry matter and neutral detergent fiber were unaffected by cultivar and averaged 701 g/kg±8.4 SEM and 503 g/kg±5.8 SEM, respectively. It was concluded that cultivars had little impact on the chemical composition and ruminal degradability of spineless cactus. Based on chemical composition and in situ ruminal degradability, spineless cactus can be considered an excellent source of fermentable carbohydrates for grazing and nongrazing ruminants. Because of its high carbohydrate quality, spineless cactus can be used as an emergency feed or as part of a complete diet provided that the diet contains an adequate amount of degradable protein.

Ayadi *et al.*, (2009) studied that, Chemical composition and physical properties of Mediterranean (Tunisian) spiny (*Opuntia ficus-indica*) and spineless cladodes (*O. ficus indica*) were studied. Chemical characterization of the two cladodes varieties showed a high fiber, minerals, especially potassium and calcium, and phenols contents. Powders obtained from spiny and spineless cladodes showed a great technological potentiality as water binding capacity (WBC) and fat absorption capacity (FAC). Cladodes powders were incorporated in wheat flours at 5%, 10%, 15% and 20% levels. Obtained results showed that cladode flours had a significant effect in wheat dough properties ( $P < 0.05$ ). Indeed, with the increase of cladodes flour levels, an increase of tenacity, energy, adhesion, stickiness, and hardness of dough was observed whereas dough elasticity decreased. A significant difference in physical characteristics between cakes fortified with cladodes flours and control was shown ( $P < 0.05$ ). With the increase of cladode flour levels in formulation, cake hardness increased. Increasing levels of cladode flours caused decreases in total sensory scores. The overall acceptability rate showed that a maximum of 5% cladode flours can be incorporated to prepare acceptable quality cakes. Cactus cladodes are high in carbohydrates (60%) and  $\beta$ -carotene (6.5 mg/kg DM).

Abidi *et al.*, (2009) conducted an experiment to study chemical composition of cactus cladodes they have observed that, Mucilage level is high in the cladodes of spineless (6-13 g/kg fresh material) and spiny (6-14 g/kg fresh material) cactus. Mucilage concentration increases at least twice in summer compared to winter. It reduces salivation in ruminants thus avoiding a rapid decrease in rumen PH.

Lins *et al.*, (2016) study aimed to assess the impact of substituting spineless cactus (0, 25, 50, 75, and 100%) for wheat bran in diets based on sugar cane on sheep's intake, nutrient digestibility, and ruminal parameters. After fitting cannulas in the rumen, five Santa Inês sheep (average beginning weight: 34.0±3.6 kg) were placed in a 5 x 5 Latin square. Dry matter and crude protein digestibility increased by 0.60 and 0.85 g kg<sup>-1</sup> of DM, With the replacement of 57.1 and 62.2% of wheat bran. Rumen pH had increased with the inclusion of spineless cactus, while the maximum concentration of ammonia N (33.3 mg dL<sup>-1</sup>) and total volatile fatty acids (57.7 μ mol mL<sup>-1</sup>) were estimated at the levels of 72.3 and 63.7% of replacement of wheat bran. It is recommended to replace 63% of wheat bran by spineless cactus in sugarcane-based diets, to promote better animal performance.

F Alhanafi *et al.*, (2019) evaluated the effect on water intake, digestibility, blood metabolites, and fattening performance, the effects of replacing 13.6% and 20.3% of a total ration of fattening Awassi lambs with two combinations of fresh saltbush (*Atriplex halimus*) and fresh spineless cactus (*Opuntia ficus*) cladodes at a ratio of 1.9:1 (TRT1) and 1.7:1 (TRT2) were assessed. Three diets (control, TRT1, and TRT2) were randomly assigned to 36 lambs with average beginning live weights of 34.5±4.18 kg each. The control diet included 166 grams of barley straw per kilogram and 834 grams of commercial concentrate mixture; TRT1 included 126 grams of barley straw, 739 grams of concentrate mixture, 47 grams of spineless cactus, and 89 grams of saltbush; and TRT2 included 67 grams of barley straw, 704 grams of commercial concentrate mixture, 86 grams of spineless cactus, and 144 grams of saltbush.

Shrutaliya *et al.*, (2022) conducted an experiment for 75 days to assess the incorporation of Spineless Cactus (*Opuntia ficus-indica*) on the growth performance of Nellore lambs. Eighteen growing Nellore lambs of uniform body weight (20.5 kg) and age (232 days) were randomly allotted to three groups and fed with one of the three diets namely, basal diet containing Super Napier (T0), 20 per cent spineless cactus along with Super Napier (T1) and 40 per cent spineless cactus along with Super Napier (T2). All the lambs were supplemented with concentrate mixture @ 2 percent of the body weight. The average daily dry matter intake (kg/day) was  $0.90 \pm 0.01$ ,  $0.87 \pm 0.01$  and  $0.86 \pm 0.01$  for T0, T1 and T2 groups, respectively and the differences were statistically significant ( $P < 0.05$ ). Nellore lambs in T0, T1 and T2 group had an average daily gain (g) of  $76.00 \pm 1.53$ ,  $72.22 \pm 2.18$  and  $70.00 \pm 1.18$  g, respectively during 75 days experimental period and the differences were non-significant. At the end of the growth trial, a five-day digestibility trial was conducted on all the lambs to assess the digestibility of nutrients in experimental diets. Higher ( $P < 0.05$ ) digestibility of DM and OM observed in spineless cactus-supplemented group lambs (T1 and T2). Water intake was significantly ( $P < 0.05$ ) lower in group T2 compared to T0 and T1 lambs. It was concluded that spineless cactus could be a good unconventional, valuable fodder resource especially in rainfed drylands and could replace other feed stuffs like super Napier. The CP content of spineless cactus was 5.62 percent and NDF & ADF values are 38.7 and 27.2 respectively. The DM content of spineless cactus was low i.e., 9.2 per cent and moisture content was high i.e., 90.8 percent and TA content is 29.2 percent.

## **2.2 Effect of inclusion of edible Spineless Cactus (*Opuntia ficus*) in rations on growth performance**

Terblanche *et al.*, (1971) stated that feeding cactus alone caused weight loss in Merino sheep. Similarly, Salem *et al.*, (2002) stated that sheep fed diets with cactus and untreated tef straw grew less than those fed cactus and urea treated tef straw ( $P < 0.01$ ). Therefore, cactus-straw based feeding systems require supplementation with protein or nitrogen sources to support animal performance.

Nefzaoui *et al.*, (2001) demonstrated that cactus was a good supplement to ammonia or urea-treated straw, since it provided the necessary soluble carbohydrates for efficient use of the non-protein nitrogen in the rumen. However, sheep gained lower live weight at higher replacement (75 per cent) which was explained by the higher moisture content in cactus which limited the total DM intake.

Salem *et al.*, (2002) observed that in the presence of nitrogen source (soybean), cactus pear replaced barley grains had no effect on growth rate of sheep. Similar results were obtained by Tegegne *et al.*, (2005) they found that if the straw is urea-treated, cactus pear could replace wheat bran. Sheep given urea treated straw along with cactus at 40 per cent, 20 per cent and wheat bran 20 per cent consumed the same amount of DM. However, sheep fed diet containing wheat bran gained higher body weight (75.5 g per day) compared to those without wheat bran (38 g per day). This was attributed to the relatively high protein and phosphorus content of wheat bran.

McDonald *et al.*, (2002) explained that, feeds with a particularly high content of water bound within plant tissues promote a lower DMI than comparable feeds of lower water content. Thus, cactus can be safely replacing straw up to 50 per cent on DM basis with positive weight gain and no digestive disturbances, provided that it was supplemented with organic nitrogen sources.

Tegegne *et al.*, (2005) study aimed at investigating the effects of cactus pear inclusion and urea-treatment of straw on the performance of sheep. A three-months experiment laid out in a randomised complete block design with eight sheep/treatment. Diets consisted of untreated wheat straw [T1], cactus pear [T2], wheat straw + cactus pear + wheat bran [T3], urea-treated straw [T4], urea-treated straw + cactus pear [T5] and urea-treated straw + cactus pear + wheat bran [T6]. The rate of supplements (Cactus and/or Wheat Bran) was 40%. Diets were offered in individual troughs twice daily, aiming at 20% refusals. At the end of the feeding trial, four sheep/group were transferred to metabolic crates for the digestibility trial (7 days). Data were subject to ANOVA using the SAS software JMP 5. Urea-treatment improved crude protein content of straw from 2.68 to

8.69% and apparent dry matter digestibility (DMD) from 55%(T1) to 65%(T4). They have found that if the straw is urea-treated, cactus pear could replace wheat bran. Sheep given urea treated straw along with cactus 24 at 40 per cent, 20 per cent and wheat bran 20 per cent consumed the same amount of DM. However, sheep fed diet containing wheat bran gained higher body weight (75.5 g per day) compared to those without wheat bran (38 g per day). This was attributed to the relatively high protein and phosphorus content of wheat bran.

Gebremariam *et al.*, (2006) studied the effect of different levels of cactus (*Opuntia ficus-indica*) inclusion on feed intake, diet apparent digestibility and live weight gain in tef (*Eragrostis tef*) straw-based feeding of sheep. A randomized complete block design was used to assign 24 male Highland sheep with initial live weight of  $17.0 \pm 3.9$  kg (mean  $\pm$  S.D.) in six replications to one of the four treatment feeds. The animals in T1 were offered 610 g tef straw on dry matter (DM) basis, and 57.6 g DM noug (*Gouzotia abyssinica*) seed cake, and those in T2, T3 and T4 were offered the same quantities of noug seed cake DM with replacement of one fourth, half and three fourths of tef straw DM with spineless cactus DM, respectively. The sheep were kept on the experimental feeds for 118 days. Spineless cactus and tef straw were offered separately to animals in two equal portions at 8:00 and 16:00 h. Common salt and fresh water were offered *ad libitum* throughout the experimental period. They have observed, an increase in body weight gain with increased levels of cactus intake in growing lambs. Cactus supplementation with cottonseed cake and peanut cake resulted in higher daily BW gain than the non-supplemented sheep.

Atti *et al.*, (2006) performed, an experiment with twenty-one kids in three groups, to compare a control group of kids fed with oat hay and concentrate feed, In second group the 50 per cent of the concentrate in control diet replaced by cactus *ad libitum* and another group fed soybean meal replacing concentrate (protein) in the second group. The animals in the control group showed higher body weight gain than other two treatment groups. Kids in the second group recorded a lower cactus intake than those fed soybean meal. Differences in performance observed between animals receiving various diets were associated

with the energy content. The energy content was low for soyabean diet than for the other diets leading to lower body weight gains.

Degu *et al.*, (2009) Studied that, the experiment was conducted at Maichew Agricultural Technical Vocational Education and Training College, Ethiopia. Twenty four male yearling Tigray Highland Sheep with mean body weight (BW) of  $21 \pm 2.6$  kg (mean  $\pm$  S.D.) were used to investigate the effect of different protein sources on feed intake, nutrient digestibility, BW change and carcass parameters in a study comprising of 90 days feeding trial, followed by 7 days of digestibility trial and evaluation of carcass parameters, the sheep supplemented with cactus along with cottonseed cake had higher slaughter weight and dressing percentage on empty BW basis than the non-supplemented ones. They opined that the basal diet consisting of cactus and tef straw promoted body weight gain in sheep indicating their usefulness under conditions of feed scarcity

Abidi *et al.*, (2009) studied an experiment in which they replaced the barley with *opuntia ficus* on iso-energy basis fed to lambs in which they observed that there was no significant difference between barley and cactus fed animals in average daily body weight gains. There was no negative effect of cactus on hay intake, digestibility or N balance with inclusion of cactus in the diet.

Mendez-Illoriente *et al.*, (2011) performed, an experiment in which a performance trial carried out, 50 intact Rambouillet  $\times$  Dorper male lambs ( $19 \pm 2.8$  kg), were randomly assigned to experimental diets containing 0, 10, 20, 30 or 40%, *Opuntia leucotrichia*. In trial two, five ruminal cannulated Rambouillet male rams were used in a digestion study. Dry matter intake, average daily gain and feed efficiency of lambs decreased ( $P < 0.05$ ) generally with increasing levels of *O. leucotrichia*. Water intake decreased as consumption of *O. leucotrichia* increased. Crude protein was digested higher ( $P < 0.05$ ) in lambs fed 40% diet than other lambs. Ruminal pH and ammonia-N were not significantly different among treatments. Inclusion of *O. leucotrichia* on feedlot lamb diets is a good option for production systems if this resource is available.

Costa *et al.*, (2012) stated that when maize grain in the concentrate mixture was replaced by cactus on dry matter basis at 0, 25, 50, 75 and 100 per

cent levels, the average daily gain (ADG) decreased from 255 to 210 g/day between the diets with 0 and 100 per cent of cactus pear replacement respectively. The reduction of the metabolizable energy supply in the diet (2.30 to 2.05 Mcal of ME/kg DM) and the reduction in ME intake from the treatment diets lead to a marginal reduction in the weight gain of the sheep. It was observed that for each additional percentage of cactus, there was a reduction of approximately 0.3785 g in the daily weight gain

Mahouachi *et al.*, (2012) studied the effect of spineless cactus incorporation in food of dairy goats and growing kids on milk production and composition and on kid's growth and meat characteristics. Two experiments were conducted on Tunisian local goats. In the first, 30 females were divided into two groups; goats of Control group were reared on grazing pasture receiving indoor 0.5 kg of hay and 0.4 kg of concentrate. Goats for the second group (Cac-FL) were kept in feedlot and fed cactus ad libitum more 0.5 kg of hay and 0.4 kg of concentrate. In the second experiment, 14 kids were divided into 2 groups receiving 600 g of hay. The Control group received ad libitum a concentrate containing 130 g crude protein (CP) per kg of dry matter. The second group received cactus ad-libitum plus the half concentrate quantity of control one with 260 g CP/kg DM (Cactus). The use of cactus, despite the reduction of concentrate, tends to improve the ADG from 35 g/day (Control) to 55 g/day (Cactus). These results showed clearly that cactus, largely used in arid and semi-arid areas for rangeland rehabilitation, is also a potential cost-effective fodder for weaned kids in semiarid areas. However, the slight difference in growth rates among treatments would suggest that the nutritive value of diets was not the only limiting factor but reflects also the low potential growth rate of this local breed.

Gusha *et al.*, (2015) studied the intake, apparent digestibility, nitrogen balance and productive performance in lamb fed spineless cactus and silage associated with forages adapted to the semiarid environment. Forty intact crossbred lambs, with an average body weight of  $22.65 \pm 1.01$  kg, were distributed in a completely randomised design with five treatments (diets based on: spineless cactus silage (SCS), spineless cactus + buffelgrass silage (SCBS), spineless cactus + gliricidia silage (SCGS), spineless cactus + Pornunça silage

(SCPS) and corn silage (CS; witness) and eight animals per treatment. Intake, apparent nutrient digestibility, nitrogen balance, and performance of animals were evaluated. The SCGS diet showed higher intake of dry matter and organic matter ( $P < 0.05$ ). The SCGS and SCPS diets showed the highest crude protein intake ( $P = 0.005$ ). Lower intake of ether extract was found in animals receiving diets containing SCS and SCBS ( $P = 0.001$ ). SCBS and SCGS provided a higher intake of neutral detergent fiber ( $P = 0.015$ ). SCS and SCGS diets displayed a higher intake of non-fiber carbohydrates ( $P = 0.003$ ). The CS promoted lower results for intake ( $P = 0.003$ ), absorbed ( $P = 0.003$ ) and balance ( $P = 0.012$ ) for nitrogen. SCGS diet provided a higher final weight ( $P = 0.006$ ). SCS and SCGS diets provided more significant body weight gain ( $P = 0.001$ ). Combining spineless cactus with a roughage base allowed weight gains over 200 g/day, proving to be efficient in diets for feedlot lamb and gains similar or superior to corn-based diets, throughout 1st month of life, lambs born to barley and cactus fed ewes had a similar growth pattern. At 10 days of age, cactus fed lambs weighed 6.8 kg compared with 6.2 kg for barley lambs. At 30 days of age, average BW of lambs of both treatments was 9.5 kg.

Mengistu *et al.*, (2016) studied the effect of supplementing different proportions of dried cactus cladode (CC) and Acacia senegal branches (ASB) fed barley straw (BS) on feed intake, digestibility, and average daily gain (ADG) using twenty four yearling male Tigray highland sheep. Experimental sheep were blocked in to six blocks of four animals based on initial body weight and randomly assigned to one of the four treatments. Treatments were ad libitum feeding of BS+ 60 g noug seed cake (T1, control), and T2, T3 and T4 were supplemented with 240 g CC+80 g ASB, 160 g CC+160 g ASB, and 80 g CC+240 g ASB DM/day, respectively in addition to T1 ration. The experiment was consisted for 90 days of feeding trial and 7 days of digestibility trials. The inclusion of ASB was significantly increased CP content of cactus cladode by 28.2, 45.1 and 54.5% for T2, T3 and T4, respectively. Neutral detergent fiber (67.6%), acid detergent fiber (57.6%) and acid detergent lignin (18%) of acacia senegal branches also decreased by 20.2, 13.7 and 11.4%; 25.4, 16.8 and 11.1%; 10.7, 5.0 and 3.6%, respectively, in those treatment through the inclusion of

cactus cladode. the CP intake, ADG and Feed conversion efficiency were significantly increased.

Kauthale *et al.*, (2017) reported that, the Cactus feeding in Osmanabadi kids also enhanced the performance of kids in terms of total body weight gain and average daily gain in body weight without any adverse effect

Islam *et al.*, (2017) compared the effect of three different supplemental feeds including oat (*Avena sativa* L.), lucerne (*Medicago sativa* L.) and spineless cactus [*Opuntia ficus-indica* (L.) Mill.] in addition to a control treatment (farmer practice without supplementation) on sheep productivity, over a 60-day period in Chakwal, Pakistan. The common ingredients of the three diets were maize grain, barley grains, wheat bran, canola meal, groundnut hay and wheat straw. Eighteen ewes of similar age and weight were allocated to each treatment, with measurements of live-weight gain recorded at 15-day intervals. Lactating ewes fed oat ( $0.076 \text{ kg day}^{-1}$ ) and lucerne ( $0.064 \text{ kg day}^{-1}$ ) supplements showed similar average daily gain (ADG) compared with cactus- and control-supplemented ewes, with the same trend observed for dry ewes. The ADG for lambs fed cactus and lucerne was greater (at  $0.083 \text{ kg day}^{-1}$  for both), compared with those fed oats and the control treatment. Weight changes of lactating ewes fed with different supplement feeds were not significantly different over the course of the experiment. Dry ewes supplemented with cactus had greater weight gains (54 kg at 15 days of supplementing and 57 kg at 60 days of supplementing) compared with oat-supplemented dry ewes (46 and 50 kg) from the first weighing interval until the end of the experiment. Based on these results, it can be concluded that supplementing sheep with cactus has a positive impact on live-weight gain, compared with solely grazing under poor rangeland conditions. Therefore, it is important to develop rations that maximize the full potential of this low-nitrogen, yet water- and carbohydrate-rich alternative feed source.

Lima *et al.*, (2019) observed that, the Spineless cactus could be included up to the level of 30% on DM basis in the finishing diets of lambs to increase the fat content of meat without compromising its sensorial properties

Knupp *et al.*, (2019) carried out meta-analysis was to determine how spineless cacti affected animal performance as well as to create and analyse formulas for predicting meat lambs' average daily gain (ADG) and dry matter intake (DMI). Data were used to build equations for predicting DMI and ADG as a function of animal and diet parameters based on eight trials. 40 treatment averages from 289 meat lambs in which cactus was included from 0 to 75% of the diet dry matter (DM). The DMI was positively correlated with initial BW, final BW, concentrate and ADG, while it was negatively correlated with cactus inclusion and ME of the diet. On other hand, ADG was positively correlated with DMI, initial and mean BW and concentrate, and it was negatively correlated with cactus inclusion.

Moura *et al.*, (2020) studied the effect of replacement maniçoba hay by spineless cactus on the performance, carcass characteristics, and meat quality of confined lambs. Thirty-two male lambs, with an average body weight of  $20.8 \pm 2.9$  kg, were fed with different levels of spineless cactus in replacement for 0, 33, 66 or 100% of maniçoba hay (i.e. 0, 200, 400, 600 g kg<sup>-1</sup> of dietary DM). The replacement maniçoba hay by spineless cactus did not influence ( $P > .05$ ) body weight at slaughter ( $29.04 \pm 0.8$  kg), but it influenced quadratically the average daily gain ( $P < .05$ ) of lambs; the maximum gain occurred with the replacement of 33% of spineless cactus to replace maniçoba hay.

Rosales-Nieto *et al.*, (2021) studied the periconceptual nutrition with cladodes from the cactus, *Opuntia ficus-indica*, with or without protein-enrichment, improved the metabolomic profile and reproductive outcomes of adult female sheep. Sixty Rambouillet ewes of similar body weight were randomly allocated among three nutritional treatments that were fed during the breeding period (34 days): Control (Control; n=20), *Opuntia* (*Opuntia*; n=20) and protein-enriched *Opuntia* (E-*Opuntia*; n=20). There were no effects of treatment on body weight but assessment of urine samples indicated that, for 76 metabolites, the Control and *Opuntia* groups differed completely ( $P < 0.05$ ), whereas there was overlap between the Control and E-*Opuntia* groups. It appears that, in *Opuntia*-fed and Control-fed sheep, different functional groups are activated leading to changes in the metabolism of glucose, tyrosine, methane, and

glycerolipids. Fertility and reproductive rate tended to be higher in the *Opuntia* (70% and 95%) and E-*Opuntia* (90% and 110%) groups than in the Control (55% and 65%), and an orthogonal contrast revealed the difference between Control and *Opuntia* to be significant for both reproductive variables ( $P < 0.05$ ). We conclude that nutritional supplementation with *Opuntia* cladodes, with or without protein enrichment, increased fertility rate and reproductive rate of female sheep, without any accompanying increases in body weight. Hence Cactus doesn't have any affect on body weight but has effect on reproductive parameters.

Shrutaliya *et al.*, (2022) conducted an experiment for 75 days on Nellore lambs for replacement of Super napier with Spineless cactus with T0 control and T1 and T2 with 20%, 40% replacement with cactus respectively. Study indicating that the incorporation of cactus in the diet will not affect much of average daily gain and body weight gain in lambs as it was nutritionally comparable with any roughages but weight gain in treatment group is lower than control group.

Djaballah *et al.*, (2022) carried experiment showed the change in the live weight of the control batch (0% substitution) is greater than for batches 15, 30 and 45% of concentrate substitution by cactus grain cake. In general, the rations influenced the final live weights of the lambs, conversely to the rate of incorporation of cactus seed cake into the ration. The same trend was observed for the mean daily gains (ADG) which were significantly different between the lots ( $P \leq 0.01$ ). The ADGs recorded during the fattening period are 191, 160, 137 and 148 g / d respectively for the 0% sub, 15% sub, 30% sub and 45% sub batches.

AS Ali *et al.*, (2023) conducted a 10-week feeding experiment to evaluate the effect of feeding total mixed rations containing different levels of cactus on growth performance, carcass characteristics, and meat quality of Awassi sheep. 12 lambs with initial body weight of  $28.67 \pm 2.29$  kg and 120 days average age were distributed in complete randomized design into three dietary groups according to crushed cactus level (T1 = 0%, T2 = 10%, and T3 = 15%) in four replicates. The means of the tested parameters were tested for significance using analysis of variance followed by least significant differences at 95% confidence level. Lambs fed T3 diet showed numerically higher ( $P > 0.05$ ) total weight gain (15.3 kg) and

average daily gain (219.1 g). Based on their live weight, forty adult goats of a local breed were divided into two groups. every goat of Barley straw weighing 0.9 kg was given to both groups. Goats in the concentration group (CC) additionally received 425g of a concentrate (a blend of 80% barley and 20% soybean) each goat per day. The goats in the cactus group (CAC) were given 2600g of cactus pads and 256g of a concentrate (a mixture of 68% barley and 32% soybean). On average, feeding schedules were used for one reproductive cycle prior to mating and for the next five weeks afterward. The addition of cactus had no impact on live weight or blood.

Bezzera *et al.*, (2023) studied the objective of this study was to evaluate the effect of increasing levels of spineless cactus on nutrient intake, ingestive behaviour, and performance of lambs in a feedlot. Thirty-two male (non-castrated) Santa Inês lambs with a mean initial body weight (BW) of  $20.4 \pm 2.60$  kg were distributed across four levels of spineless cactus: zero, 24, 52, and 75% of total diet dry matter (DM). Over 56 days, the animals had their intake and performance monitored. The inclusion of SC influenced the maximum daily gain of 0.237 kg/day was achieved with 44% Spineless Cactus in the diet. Drinking water intake decreased linearly.

## **2.3 Effect of Spineless Cactus (*Opuntia ficus*) feeding on Haematological & Biochemical Parameters**

### **2.3.1 Haematological**

Antunovic *et al.*, (2002) reported that, the influence of various factors such as age, season, growth performance, reproductive status and farming systems upon blood parameters are necessary to determine the nutritional status of animals for undertaking the prophylactic measures to counter the health disorders and to increase the productivity.

Alhanafi *et al.*, (2019) studied the effect of replacing 13.6% and 20.3% of a total ration of fattening Awassi lambs by two combinations of fresh saltbush (*Atriplex halimus*) and fresh spineless cactus (*Opuntia ficus-indica*) cladodes at a ratio of 1.9:1 (TRT1) and 1.7:1 (TRT2) on water intake, digestibility, blood

metabolites, and fattening performance was evaluated. Thirty-six lambs with average initial live weight  $34.5 \pm 4.18$  kg were randomly assigned to three diets, observed that, the all blood parameters related to protein metabolism tended to be higher than that of the control group. Concentration of glucose and triglycerides was only numerically but insignificantly higher in TRT1 and TRT2 compared with the control group. However, hemoglobin and packed cell volume levels of Awassi lambs were similar across all experimental treatments.

Salem *et al.*, (2019) carried out research to study how goat reproductive parameters and blood metabolites are affected when barley is substituted with cactus during the pre-mating period. Based on their live weight, forty adult goats of a local breed were divided into two groups. every goat of barley straw weighing 0.9 kg was given to both groups. Goats in the concentration group (CC) additionally received 425g of a concentrate (a blend of 80% barley and 20% soybean) each goat per day. The goats in the cactus group (CAC) were given 2600g of cactus pads and 256g of a concentrate (a mixture of 68% barley and 32% soybean). On average, feeding schedules were used for one reproductive cycle prior to mating and for the next five weeks afterward. The addition of cactus had no impact on live weight or blood.

Morshedy *et al.*, (2020) studied, Fifteen multiparous Barki ewes (2–3 years old,  $46.94 \pm 0.59$  kg body weight, BW) at postpartum were individually distributed in three equal groups and fed diets supplemented with PPCP at doses of 0, 5 and 10 g/head/day. Lambs were individually distributed into three equal groups according to their mothers' groups to investigate the maternal effect on lambs' growth performance, hematology and serum metabolites. This trial lasted for 56 days from birth to weaning the haematological parameters of suckling ewe lambs fed diets supplemented with prickly pear cactus peels (PPCP) and reported that when prickly pear fed 0 g/head/day the RBC ( $\times 10^6$  /mm<sup>3</sup>) count was 9.19, Hb (g/dl) was 11.69, WBC ( $\times 10^3$  /mm<sup>3</sup>) count was 9.35 and PCV (%) was 38.10. When prickly pear fed 5 g/head/day the RBC ( $\times 10^6$  /mm<sup>3</sup>) was 9.93, Hb (g/dl) was 11.82, WBC 31 ( $\times 10^3$  /mm<sup>3</sup>) count was 9.48 and PCV (%) was 39.30, while prickly pear fed 10g/head/day, the RBC ( $\times 10^6$  /mm<sup>3</sup>) count was 10.86, Hb (g/dl) was 12.10, WBC ( $\times 10^3$  /mm<sup>3</sup>) count was 10.08 and PCV (%) was 36.79 and

there was no effect observed in the RBCs, WBCs, Hb and PCV of lambs suckling from ewes fed diets supplemented with PPCP.

Shrutaliya *et al.*, (2022) conducted an experiment for 75 days on Nellore lambs for replacement of Super Napier with Spineless cactus with T0 control and T1 and T2 with 20%, 40% replacement with cactus respectively the at the end of the experiment all the experimental (T0, T1 and T2) group lambs had normal haematological (RBC, WBC, Hb) values which are within the physiological range. The values of all agranulocyte indices were statistically non-significant among the three experimental group lambs at the end of experiment. Granulocyte indices were differed significantly ( $P < 0.05$ ) among the three experimental group lambs at the end of experiment and highest Granulocytes were found in T2 than T0 and T1 group lambs, however all are with in normal physiological limits.

### **2.3.2 Biochemical**

Karim *et al.*, (2000) reported that a glucose concentration was 50.2 mg/dl and blood total proteins, albumin and globulin concentration ranged from 9.0-10.08, 4.2-4.8 and 4.2-6.1 percent, respectively in Malpura lambs and it was within the normal range under intensive system of management.

Ramesh Kumar *et al.*, (2003) reported that albumin and globulin level ranged in between 2.50 to 3.98 g/dl and 1.83 to 3.26 g/dl in Mecheri sheep. Further the SGOT ranged between 28.50 to 59.0 IU/L while SGPT level 2.00 to 7.50 IU/L in Mecheri sheep.

According to Rekik *et al.*, (2010) glucose plasma concentrations at 2 weeks prior to lambing were higher in ewes that were supplemented with cactus ( $P < 0.05$ ) similarly the situation was changed 2 weeks after lambing, with ewes supplemented with barley showed higher concentration ( $P < 0.05$ ). Ewes supplemented with cactus had a higher concentration of Ca than ewes supplemented with barley ( $P < 0.05$ ). Concentrations of blood metabolites within the ranges of physiological levels were reported for sheep (Kaneko, 1997) and within the figures reported by Antunović *et al.* (2002) and Balikci *et al.* (2007) for pregnant and lactating sheep. No major effect of the diet was noticed on the

plasma mineral composition. The high level of Ca in cactus leads to the higher level of plasma Ca in cactus-fed ewes (Salem *et al.*, 2002).

Alhanafi *et al.*, (2019) recorded that, the biochemical parameters of lambs in the control (166 g/kg barley straw and 834 g/kg concentrate mixture), Treatment 1 (saltbush and spineless cactus cladodes replaced 24% of barley straw and 11% of the concentrate mixture (on a DM basis) of the control group), and Treatment 2 (saltbush and spineless cactus cladodes replaced 60% of barley straw and 16% of the concentrate mixture (on a DM basis) of the control group) and reported that the levels of all blood metabolites of lambs were not different ( $P > 0.05$ ) among treatments. All blood parameters related to protein metabolism in the treatment group tended to be more than that of the control group. Concentration of glucose and triglycerides was higher in Treatment 1 and Treatment 2 compared with the control group. Cholesterol level of Treatment 1 and Treatment 2 tended to be less than that of the control group. Calcium and phosphorus levels were numerically higher in Treatment 1 and Treatment 2 compared with the control group.

Cardoso *et al.*, (2019) studied the intake of nutrients and water, digestibility, nitrogen balance, microbial protein synthesis, performance and blood parameters of lambs fed increasing levels (0, 150, 300 and 450 g/kg of DM basis) of fresh spineless cactus *cv. Miúda (Nopalea cochenillifera)* included in the diet. Forty male (non-castrated) crossbred Santa Inês lambs, averaging  $18.6 \pm 2.8$  kg body weight (BW) at the beginning of the study, were used in this trial, reported that, there was a quadratic effect on serum glucose and calcium levels with maximum values of 87.36 and 9.1 (mg/dl) for glucose and calcium respectively, at the inclusion of 368.9 and 150 g/kg of spineless cactus, whereas 30 serum levels of triglycerides, cholesterol, creatinine, albumin, uric acid, total proteins and the enzyme aspartate aminotransferase were not influenced.

Morshedy *et al.*, (2020) reported that, the blood biochemical parameters of suckling ewe lambs fed diets supplemented with two levels of prickly pear cactus (*Opuntia ficus-indica*) peels. Serum total protein and globulin was increased ( $p = 0.044, 0.031$ , respectively) with 5 g prickly pear cactus peels compared to the

control group (0 g cactus). Cholesterol, triglycerides decreased significantly in the lambs suckling from ewes fed diets supplemented with 5 g prickly pear cactus peels compared to control group. Serum glucose, AST and ALT did not differ significantly among different treatments also observed a similar Triglycerides, SGOT and SGPT values, whereas contrary in glucose and total protein concentration when lambs fed diets supplemented with two levels of prickly pear cactus (*Opuntia ficus*) peels.

Shrutaliya *et al.*, (2022) conducted an experiment for 75 days on Nellore lambs for replacement of Super napier with Spineless cactus with T0 control and T1 and T2 with 20%, 40% replacement with cactus respectively. The inclusion of spineless cactus in the diets seems to increase serum total proteins and triglycerides, however liver function tests (SGPT and SGOT concentrations) before start of the experiment and at the end of the experiment were comparable among the three experimental group lambs All these indicating, spineless cactus does not contain any toxic substances which can harm liver.

Silva *et al.*, (2023) carried out the reaseach work to study how the metabolic profiles of lambs were affected by a partial replacement (750g/kg) of Tifton hay with two cactus cladodes, *Opuntia* and Nopalea. Thirty-six male Santa Inês lambs who were uncastrated and weighed an initial  $22.0 \pm 2.9$  kg were divided into groups using a completely randomised design. Each group received three treatments and twelve repetitions. Blood samples was collected one day before and 45 days after the introduction of the treatment diets. The cactus cladodes caused an increase ( $P=0.055$ ) in the serum activity of the gamma-glutamyl transferase enzyme (53.66U/L) and in the blood content of glucose and fructosamine.

#### **2.4 Economics of feeding Spineless Cactus (*Opuntia ficus*)**

Nefzaoui *et al.*, (2001) observed that, the sustainable and cost-effective alternative for sheep producers in many arid and semi-arid countries is the native spineless cactus or nopal *Opuntia ficus* which is abundant in dryland regions. Farmers can achieve a high intake of cactus cladodes over 3.5 kg of freshly sliced-cladodes per day for a sheep weighing 40 kg without any adaptation. Compared to

concentrate, the integration of cactus cladodes could potentially reduce the costs of feeding sheep by up to 40%. Spineless cactus use can reduce concentrate supplementation effective cost in the dry season due to being able to withstand prolonged droughts and having high production potential in these regions. According to Ben Salem and Abidi (2009), total replacement of concentrated feeds (such as corn or barley) by spineless cactus can be performed without causing any negative effect in ruminants which reduces concentrate feed cost.

Costa *et al.*, (2013) studied evaluate the feeding behavior and performance of Santa Ines sheep subjected to different levels of substitution of corn by cactus pear in the diet. Forty-five non-castrated male Santa Inês sheep with initial live weight of  $27.50 \pm 0.48$  kg were distributed in a completely randomized design with five treatments (0, 70, 140, 210 and 280 g/kg DM) and nine replicates. Dry matter and neutral detergent fiber intakes showed quadratic behavior. Times spent eating, ruminating and total ruminating chews showed increasing linear behavior, while the idle time decreased with increasing amounts of dietary cactus. The feeding efficiency (gDM/h) increased linearly, while differences in rumination efficiency of the DM (g DM/h); NDF intake efficiency (gNDF/h) and NDF rumination efficiency (gNDF/h) were not significant. There was no significant effect for the number of ruminated boli and number of ruminating chews per bolus. The number of chews per day increased linearly. These results indicate that cactus pear in substitution of corn had no influence on the feeding behavior of feedlot sheep. It shows that there is good feeding efficiency of cactus hence Cactus can be used as unconventional fodder also it is more economical also.

Grunwaldt *et al.*, (2015) reported that, the economic feasibility of replacing corn by cactus in different percentages taking into consideration the price of purchased corn and cost of cactus, in all the alternatives, except for metal fence and 1 year-old cladodes, replacement of corn by cactus implies a decrease in the diet cost when the replacement level of cactus increased. The situation without fence and using 1, 2 and 3-year-old cladodes to replace at the level of 25, 50, 75 and 100% of corn in the diet, would result in savings of US\$ 1.04, 2.07, 3.11 and 4.14, respectively, for every 100 kg of ration.

Santos *et al.*, (2017) studied that, the present study showed that spineless cactus could replace a significant part of concentrate feedstuff as wheat bran. This becomes crucial for semi-arid regions once this input cannot be produced, necessitating its importation from other areas and consequent high prices. The total cost per kilo DM according to current prices was estimated at (U\$/kg DM) 0.29; 0.23; 0.21; 0.19, and 0.18 for replacement of 0%, 25%, 50%, 75%, and 100%, respectively.

Ajith *et al.*, (2017) Studied an experiment was conducted to assess the optimum level of inclusion of spineless cactus (*Opuntia ficus-indica*) on growth performance of lambs receiving straw based diets. Eighteen lambs averaging 12.4 kg body weight (3-4 months of age) were divided into 3 groups of six each. Group 1 (T1) received a control diet comprising urea treated finger millet (*Eleusine coracana*) straw and a compounded feed mixture (CFM) based on corn. Groups T2 and T3 received the same diet except that the spineless cactus replaced the CFM at 30 and 50 per cent, respectively. The growth trial lasted for 12 weeks. Digestion trial was completed in all animals during the last week of the study. The intake of dry matter and nutrients were similar among the treatment groups. The average daily body weight gain (g/day) was 72.1, 74.2 and 70.0 for T1, T2 and T3, respectively with no significant difference among the groups. Similar body weight gain of T2 and T3 groups compared to the control group in this study indicated that the incorporation of cactus in the diet will not affect the body weight gain of lambs. The daily intake of ME in the three treatment groups were similar.

Alhanafi *et al.*, (2019) studied that, pinpoints that a mixture of saltbush and spineless cactus (1.7 saltbush:1 spineless cactus cladodes) can be introduced to fattening sheep diets replacing 60% of barley straw and 16% of the concentrate mixture which would decrease feeding cost without any adverse effect on health and growth.

Soares *et al.*, (2020) reported that, the diets consisted of four levels (0%, 11.5%, 23.5%, and 35% on a dry matter (DM) basis of Orelha de Elefante Mexicana (OEM) spineless cactus as a replacement for Miúda (MIU) spineless cactus and a control diet commonly used in the region for dairy goats based on

Tifton hay, corn, and soybean meal. A lower cost per kg DM was obtained with the 35% OEM diet. This was described by the higher DM content in the OEM composition (14.2%) compared to that of Miúda MIU (11.3%), resulting in the cost per kg DM being higher than that for OEM. The price of the control feed was \$0.44/kg DM, with the Tifton-85 hay (\$0.57/kg DM) as the costliest feed ingredient. This increase in the price of bulky ingredients is due to the supply and demand relationship in the region.

Thakuria *et al.*, (2020) studied that the opuntia ficus-indica, a fast-growing xerophytic plant, is well adapted to dry environments. It is still green in the summer and can be used as a feed. amid a time of scarcity. It may thrive on poor soils and with little water, although its productivity is higher in areas with irrigation systems and fertile soils. It is more tolerant of salinity and doesn't require well-drained soils. 20–200 tonnes DM/ha can be produced by cactus each year in biomass terms. The benefit of cactus pears is that they provide animals with water, especially during the dry season. The effects of Tifton hay replacement on the physical, chemical, and sensory characteristics of meat were investigated. The spineless cactus changed the chemical composition of meat, increasing its protein and fat contents. Lambs fed diets with 150 and 300 g kg<sup>-1</sup> (DM) replacement levels showed the highest values. The growth performance from 23.7 to 37.3 kg of body weight (on average) was unaffected by the spineless cactus. There is however, a dearth of information about its impact on meat characteristics. The impact of include spineless cactus at four different levels (0, 150, 300) in lambs' finishing diet.

Todaro *et al.*, (2020) evaluated the nutritional traits of PPB for ruminant feeding and its stability during a 21-day outdoor storage, using potassium metabisulfite (PMB) as a preservative agent, added to the PPB mass at different doses (0, 50, 100, and 150 g/kg). The fractioning of PPB showed that it included 28% of peel and pulp and 72% of seeds on a dry matter (DM) basis. On the whole, this by-product was low in crude protein (5.32% DM), high in fiber content (51.38%, 41.15% and 14.64% DM for NDF, ADF and ADL respectively), non-fiber carbohydrates (NFC, 29.68% DM), and soluble sugars (13.3% DM), with a moderate level of net energy for lactation (4.59 MJ/kg DM). This preliminary

investigation showed this by-product could represent, for its chemical composition, an interesting and suitable feeding source to be used to increase the environmental and economic sustainability of ruminant livestock.

GF Pereira *et al.*, (2021) this study examined the effects of substituting spineless cactus for grain analysis and nutrient intake determination. The costs of producing diets were also calculated for maize in dairy goat diets on dry matter consumption, water intake, milk yield, milk physicochemical properties, and diet production costs. In a double 44 Latin square design, eight multiparous Anglo Nubian goats were fed diets that substituted spineless cactus for grain maize at samples were taken for physicochemical.

K Balduino da Silva *et al.*, (2021) the impact of diets with 0% wheat bran levels (control buffalo grass and cactus pear) in comparison to diets with cactus pear as the primary forage source and 30%, 37%, and 44% of wheat bran levels on nutritional digestibility, feed intake, animal performance, carcass characteristics and Analysis of the economics was assessed. Crossbred male lambs weighing 22.6 kg and not castrated were confined for 62 days. Four treatments and seven repeats were employed in a fully randomized approach. In order to achieve the necessary mean daily weight gain of 200 g/animal/day, four diets were developed. Using the 5% Dunnett test, means were contrasted. Animals fed just cactus pear (diets containing 30; 37; and 44 percent wheat bran) showed lower dry matter intake and nutritional intake.

Sandeepkumar *et al.*, (2022) experimented that, the Cactus is highly succulents (85% water) and has a high biomass potential crop that provides 180 tonnes/ha/ year of water stored in their cladodes and produce more than 20 tonnes of dry matter/ ha/ year. It is a cost-effective supplementation for livestock water as well as nutrition. Its succulent and drought-tolerant behaviour enables the animals to survive for a long time without water in water deficit areas. Primarily, it can provide year-round fodder availability either in fresh forage or as stored feeding.

Silva *et al.*, (2023) explained that, the feeding cost of the control diet/animal (US\$3.37) was higher than the cost of the diet/animal with cactus pear as the only forage source and 44% of wheat bran (US\$1.81, Table 9).

Nevertheless, the gross revenue and total revenue per animal unit was higher for the control diet and lower in the diet of animals fed cactus pear and 37% of wheat bran.

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# *Materials & Methods*

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## CHAPTER III

### MATERIALS AND METHOD

#### 3.1 Place of research work:

The present research work entitled “Effect of feeding Cactus (*opuntia ficus*) on growth performance of Madgyal lambs” was carried out at the “Madgyal Sheep Unit” of Punyashlok Ahilyadevi Sheep and Goat Development Corporation, Dahiwadi, Dist.-Satara. (M.S), for a period of 90 days during August to October 2023. Laboratory work was undertaken in the Department of Veterinary Biochemistry at Krantisinh Nana Patil College of Veterinary Science, Shirwal, Dist.-Satara, (M.S) and ICAR- National Institute of Abiotic Stress Management, Malegaon, Baramati, Dist-Pune, (M.S).

#### 3.2 Environmental conditions:

The present research work was conducted at the “Madgyal sheep Unit” of Punyashlok Ahilyadevi Sheep and Goat Development Corporation, Dahiwadi, Dist. Satara. (M.S). The climate of the region as a whole is hot and dry except during the monsoon season. The temperature increases steadily after the fortnight of February month, till the first week of June which is the hottest part of the year with the mean daily (maximum) temperature at 35°-40°C.

#### 3.3 Selection of experimental animals:

For the present study, eighteen (18) healthy Madgyal lambs which were of 3 to 4 months of age of either sex with uniform body size and weight were selected. They were randomly divided into three (03) groups (**T0**), (**T1**) and (**T2**) as treatments involving six lambs in each group. (**T0**) was the control group and (**T1**) and (**T2**) were the treatment groups. Deworming of all the experimental lambs was done before the start of the experiment and were given 15 days adaptation period to avoid errors due to stress before the actual work. The details regarding experimental Madgyal lambs selected for the experiment are presented in Table 3.1

**Table 3.1 Details of the experimental Madgyal lambs.**

<b>Groups</b>	<b>Sr. No</b>	<b>Tag no of experimental animals</b>	<b>Initial body weights of experimental animals (Kg)</b>
<b>T0 (Control)</b>	<b>1</b>	T <sub>0</sub> 1	16
	<b>2</b>	T <sub>0</sub> 2	17.5
	<b>3</b>	T <sub>0</sub> 3	18
	<b>4</b>	T <sub>0</sub> 4	18
	<b>5</b>	T <sub>0</sub> 5	17.6
	<b>6</b>	T <sub>0</sub> 6	16.9
<b>Average</b>			<b>17.33±0.33</b>
<b>T1 (Treatment)</b>	<b>1</b>	T <sub>1</sub> 1	16.7
	<b>2</b>	T <sub>1</sub> 2	16.8
	<b>3</b>	T <sub>1</sub> 3	17.4
	<b>4</b>	T <sub>1</sub> 4	18.4
	<b>5</b>	T <sub>1</sub> 5	18.2
	<b>6</b>	T <sub>1</sub> 6	16.5
<b>Average</b>			<b>17.33±0.31</b>
<b>T2 (Treatment)</b>	<b>1</b>	T <sub>2</sub> 1	17.4
	<b>2</b>	T <sub>2</sub> 2	17.3
	<b>3</b>	T <sub>2</sub> 3	16.8
	<b>4</b>	T <sub>2</sub> 4	16.7
	<b>5</b>	T <sub>2</sub> 5	18.2
	<b>6</b>	T <sub>2</sub> 6	17.6
<b>Average</b>			<b>17.33±0.21</b>

### **3.4 Housing, Management and Health Care:**

#### **3.4.1 Housing and Management:**

The animal house was of the intensive type and well-ventilated (comfortable) shed having proper flooring, lighting and locking arrangements



**Plate no 3.1: Spineless cactus (*Opuntia ficus*) ICAR-NIASM farm land baramati.**

with sufficient space and practised good hygiene on the farm. The experimental lambs were divided into three different groups i.e., T0- control group, whereas, T1 and T2 were treatment groups. All the experimental animals were housed 15 days before the start of actual research work, to adapt them to present climatic conditions. All the experimental animals were dewormed and vaccinated before the start of the actual research work.

#### **3.4.2 Farm feeding:**

Feed was given daily in the early morning and evening time of day. All the feeders were cleaned before feeding. After calculating the minimum amount of feed from the previous day the feed was offered. The feeding of concentrate and roughages was followed separately throughout the experiment. Clean fresh drinking water was made available for 24 hours.

#### **3.5 Feeding of experimental animals:**

Feed was given daily in early morning and evening time of day. All the feeders were cleaned before feeding. The feed was offered after calculating the minimum amount of feed of the previous day. The feeding of basal concentrate mixture and roughages with replacement of 20% & 40% Green roughages with Spineless Cactus (*Opuntia ficus*) in T1 & T2 groups respectively. Along with 2% concentrate mixture was given. To estimate voluntary intake, the leftovers from the previous day were collected and weighed before the morning offering. The intake was measured by the difference between the feed supplied and leftover for each animal and the quantity supplied was adjusted every day, based on the voluntary intake of the animal with an estimated 10% leftover. Clean fresh drinking water was available for 24 hrs. Experimental animals were fed in groups. The animal house was of intensive type lamb house was well ventilated with sufficient space and practised good hygiene in the farm. Details of the Feeding Management Schedule for the Madgyal lambs were elaborated in Table No. 3.2.

**Table 3.2: Details of Feeding Management Schedule for the experimental animal**

Sr. No.	Experimental Groups	No. of Experimental animals	Experimental Diet
1.	T <sub>0</sub>	06	Basal Concentrate mixture + Green roughages without Spineless Cactus. (ICAR, 2013)
2.	T <sub>1</sub>	06	Basal Concentrate mixture + Chopped Spineless Cactus in which 20% of Green roughage replaced by Spineless Cactus. (ICAR, 2013)
3.	T <sub>2</sub>	06	Basal Concentrate mixture + Chopped Spineless Cactus in which 40% of Green roughage replaced by Spineless Cactus. (ICAR, 2013)

### 3.6 Parameters to be studied

#### 3.6.1 Composition of Spineless Cactus (*Opuntia ficus*)

##### 3.6.1.1 Proximate analysis

Sample of Spineless cactus was collected and dried in a hot air oven at 100±5°C till constant weight and then grounded in a laboratory Willey mill and preserved in air tight containers for further chemical analysis. The proximate analysis of Spineless cactus was performed as per the procedures described by AOAC (2005).

##### 3.6.1.1.1 Dry matter (DM)

The DM content of feed was determined by drying a weighed amount of sample in a moisture cup overnight at 100 ± 2°C to a constant weight. The weight



**Plate 3.2 : Harvesting and collectin of Spineless cactus (*Opuntia ficus* ).**



**Plate 3.3 : Manully Chopping of Spineless cactus (*Opuntia ficus*) with the help of Knife Cutter.**



**Plate no 3.4: Chopping Spineless Cactus (*Opuntia ficus*) Fed with a mix of concentrate mineral mixture.**

of the dried sample expressed as a percentage of the original air dried sample represented the per cent DM in the sample.

#### **3.6.1.1.2 Crude protein (CP)**

A known quantity (0.5g) of the ground samples (appropriate aliquots) were digested using Tecator Digestion systems (FOSS, Denmark) with suitable quantity of concentrated H<sub>2</sub>SO<sub>4</sub> in the presence of catalytic digestion mixture (CuSO<sub>4</sub> and K<sub>2</sub>SO<sub>4</sub> in 1:10 ratio). An acid blank was also run along with the samples for correction of any N contribution by the acid itself. The N content of the sample was estimated by distilling in auto analyzer (Kjeltec\_8400, FOSS, Denmark). The N content multiplied by the factor 6.25 to gave the CP content of the sample, which was expressed as percentage on DMB.

#### **3.6.1.1.3 Ether extract (EE)**

A known quantity of moisture free sample was extracted with petroleum ether (60-80°C) for 8 h in a pre-weighed oil flask using Soxhlet extraction apparatus. The extracted crude fat in the oil flask was oven dried to a constant weight and expressed as EE percentage on DMB.

#### **3.6.1.1.4 Total ash (TA) and organic matter (OM)**

Weighed and decarbonized samples were ashed in a muffle furnace at 550-600°C for 3 hrs The weight of residue left was expressed as per cent total ash on DMB. Organic matter was obtained by deducting the per cent total ash on DMB from 100.

#### **3.6.1.1.5 Crude fibre (CF)**

The crude fiber was estimated by treating the sample with 1.25% H<sub>2</sub>SO<sub>4</sub> and 1.25% NaOH and the residue left was ashed in a muffle furnace at 550-600°C. The loss due to ashing was considered as crude fibre.

#### **3.6.1.1.6 Nitrogen free extract (NFE)**

Nitrogen free extract was obtained by subtracting the sum of CP, EE, CF and total ash percentage from 100.

### **3.6.1.2 FIBRE FRACTIONS ANALYSIS**

Analysis of fibre fractions in feed were performed as per the method described by Van Soest *et al.* (1991).

#### **3.4.1.2.1 Neutral detergent fibre (NDF)**

Neutral detergent fibre was estimated by using ANKOM<sup>200</sup> fibre analyser by refluxing the sample with neutral detergent solution (PH 7.2) for 1 h to a constant volume and the residue left was dried in hot air oven at  $100 \pm 2^{\circ}\text{C}$ . The weight of the dried sample expressed as neutral detergent fibre in per cent.

#### **3.6.1.2.2 Acid detergent fibre (ADF)**

The Acid detergent fibre was estimated similar to NDF in ANKOM<sup>200</sup> fibre analyser by refluxing sample with acid detergent solution (PH 2.0) for 1 h to a constant volume and the residue left was dried in hot air oven at  $100 \pm 2^{\circ}\text{C}$ . The weight of the dried sample expressed as acid detergent fibre in per cent.

#### **3.6.1.2.3 Acid detergent lignin (ADL)**

After ADF estimation the samples of ADF are taken in the crucibles and they are placed in the glass tray which is kept 2cm high at one end so that acid will drain away from the crucibles. Covered the contents of the crucible with cooled 72 per cent  $\text{H}_2\text{SO}_4$  and stirred with glass rod to a smooth paste, breaking all lumps. Filled the crucible half away with acid and stirred with a glass rod and kept glass rod in crucible only, refilled with 72 per cent  $\text{H}_2\text{SO}_4$  and stirred at hourly intervals as acid drained away like this 3 times acid is refilled as it drained away. After 3 hours, filter off as much acid as possible with a vacuum, then washed contents, with hot water until free from acid. Rinsed and removed the stirring rod. Dried crucibles overnight at  $100^{\circ}\text{C}$  and weights are taken. Ignited the crucibles in a muffle furnace at  $400^{\circ}\text{C}$  for 1 hour, and then cooled and weights were taken.

### **3.6.2 Growth Performance**

#### **a) Fortnight body weight (kg)**

The experimental lambs were weighed individually at fortnightly intervals on 0, 15, 30, 45, 60, 75 and 90<sup>th</sup> day using an electronic weighing balance. The



**Plate no 3.5: Identification of Madgyal lambs**



**Plate no 3.6 : Feeding of Spineless cactus (*Opuntia ficus*) to Madgyal lambs.**

weight was taken in the morning hours i.e., between 8 to 9 am before feeding and watering for accuracy.

#### **b) Average daily gain in body weight**

Average daily weight gain was calculated to determine experimental lambs' growth rate in different groups. The body weight of experimental animals will be taken at fortnightly intervals. From the data generated, the average daily gain in body weight of experimental lambs will be calculated using body weight readings of current fortnights and the previous one.

$$\text{ADG} = \frac{\text{Final weight (Kg)} - \text{Initial weight (Kg)}}{\text{Days of feeding trial}}$$

#### **3.6.3 Haematological and Biochemical Parameters**

Blood samples were collected on monthly intervals from the jugular vein of all the experimental animals, before the morning feeding with the help of sterilized needles. The experimental animals were restrained and then sterilised hypodermic needles were used for blood collection. The area was first sterilized by using surgical spirit and 2.5 ml of blood was collected by vacutainer vials EDTA vials for haematology and analysis was undertaken with the help of a haemoanalyser. Each time two blood samples were collected from each animal, one sample of 5 ml in heparinized vacutainer, for haematology and the other 5 ml in the vacutainer coated with clot activator for serum separation. The serum was separated by centrifugation at 2500 rpm for 15 min and transferred to 5 ml Eppendorf tubes which were stored at  $-20^{\circ}\text{C}$  till use.

Blood samples of experimental animals were collected from all the experimental lambs at monthly intervals (0, 30, 60 and 90th day) for haematological study. For blood biochemical parameters, serum was separated from 2.5ml blood collected in serum activator vials and will be analyzed using commercial kits on an auto-analyzer (Model –FALCON, 260).

### A) Hematological parameters

Hb (Hemoglobin)

PCV (Packed Cell Volume)

TLC (Total Leukocyte Count)

TEC (Total Erythrocyte Count)

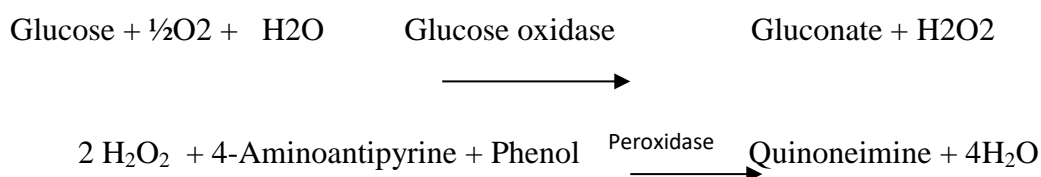
### B) Biochemical parameters

#### ESTIMATION OF BIOCHEMICAL PROFILE

The concentration of glucose, total proteins, albumin, SGOT (Aspartate Amino Transferase), and SGPT (Alanine Amino Transferase) were estimated in serum.

##### 3.6.3.1 Glucose

**Principle:** Glucose in the presence of glucose oxidase and peroxidase enzymes gives a coloured complex, which was measured by a spectrophotometer at 505 nm.



**Reagents:** The reagents used to detect the glucose levels in the plasma were: Phosphate 100mmol/L, phenol 5 mmol/L, Glucose oxidase >10U/ml, Peroxidase > 1U/ml, 4-aminoantipyrine 0.4 mmol/L, with pH 7.5, Glucose standard with a concentration of 5.55 mmol/L (100mg/dL). All reagents were stored at 2-8°C.

**Procedure:** The reagent was brought to room temperature initially. The test tubes were labelled in a required manner. Then pipetted 10µl of each sample and standard into the specifically labelled test tubes. A blank was set with 10µl distilled water and 1ml reagent. To every test tube 1ml of reagent was added, mixed thoroughly, and all are incubated at room temperature for 10 mins. After incubation, absorbance of the colour developed in the standard and tests was read against blank at 505 nm using a spectrophotometer and the concentration of the glucose was obtained.



**Plate no 3.7: Blood of collection of experimental Madgyal lambs**

### 3.6.3.2 Total Proteins

**Principle:** The protein present in the plasma sample reacts with copper (II) ion in alkaline medium forming a colored complex that can be measured by spectrophotometer at 545nm.

**Reagents:** Copper (II) acetate 6mmol/L, Potassium iodide 12mmol/L, Sodium hydroxide 1.15mol/L, and protein standard (Bovine albumin) with concentration of

60.2g/L. All reagents are stored at room temperature.

**Procedure:** The test tubes were labelled in a required manner. Then pipetted 20µl of each sample and standard into the specifically labelled test tubes. A blank was set with 20µl distilled water and 1ml reagent. To every test tube 1ml of reagent was added, mixed thoroughly, and all are incubated at room temperature for 10 min. After incubation, the absorbance of the colour developed in the standard and tests was read against blank at 545 nm using a spectrophotometer and the concentration of the total protein was obtained.

### 3.6.3.3 Albumin

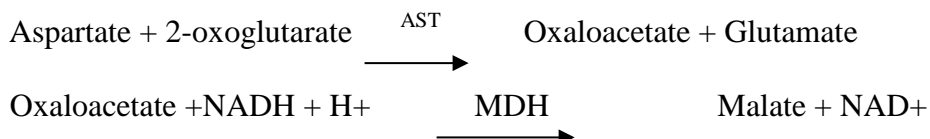
**Principle:** The Albumin present in the plasma sample reacts with bromo cresol green in the acid medium and finally gives coloured complex that can be measured by the spectrophotometer at 630nm.

**Reagents:** Acetate buffer 100 mmol/L pH 4.1, bromocresol green 0.27 mmol/L, and albumin standard at concentration of 4.87g/dL. All reagents were stored at 4°C.

**Procedure:** The test tubes were labelled in a required manner. Then pipetted 10µl of each sample and standard into the specifically labelled test tubes. A blank was set with 10µl distilled water and 1ml reagent. To every test tube 1ml of reagent was added, mixed thoroughly, and all are incubated at room temperature for 1 min. After incubation, the absorbance of the colour developed in the standard and tests was read against blank at 630 nm using a spectrophotometer and the concentration of the albumin was obtained.

### 3.6.3.5 Serum Glutamic Oxaloacetic Transaminase (SGOT)

**Principle:** Aspartate amino transferase catalyses the transfer of amino group from aspartate to 2-oxoglutarate, forming oxaloacetate and glutamate. Catalytic concentration is determined from the rate of decrease of NADH, measured at 340nm, by means of malate dehydrogenase (MDH) coupled reaction.



**Reagents:** The two reagents A and B, used for the quantitative estimation of Aspartate aminotransferase present in the plasma samples, have the following composition:

Reagent A: Tris 121 mmol/L, L-aspartate 362mmol/L, malate dehydrogenase >460U/L, lactate dehydrogenase >660U/L, sodium hydroxide 255mmol/L, pH 7.8.

Reagent B: NADH 1.3 mmol/L, 2-oxoglutarate 75 mmol/L, sodium hydroxide 148 mmol/L, sodium azide 9.5g/L. All reagents were stored at 4<sup>0</sup>C. The working reagent was prepared by mixing reagents A and B in 4:1 ratio just before the assay.

**Procedure:** The test tubes were labelled in a required manner. To every test tube, 1ml of working reagent was added. To the specified tube containing the reagent, a 50±1 sample was added and mixed well. After mixing the initial absorbance was recorded and thereafter at 1-minute intervals for 3 min. The average absorbance difference per minute and the amount of SGOT in the sample was calculated.

### 3.6.3.6 Serum Glutamic Pyruvic Transaminase (SGPT)

**Principle:** Alkaline aminotransferase catalyses the transfer of amino group from alanine to 2-oxoglutarate forming pyruvate and glutamate. Catalytic concentration is determined from the rate of decrease of NADH measured at 340 nm using lactate dehydrogenase (LDH) coupled reactions.



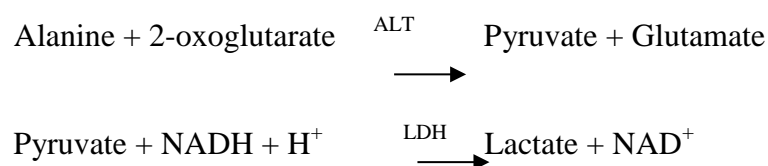
**Plate no 3.8 : Analysing serum sample on the Erba Mannheim, CHEM 7, Semi-automated clinical chemistry analyzer.**



**Plate no 3.9 : Erba Mannheim, CHEM 7, Semi-automated clinical chemistry analyzer**



**Plate no 3.10: Abacus jr. vet 5, Diatron Hungary, haemoanalyzer**



**Reagents:** The two reagents A and B, required to estimate the SGPT levels in the plasma samples has the following composition.

Reagent A: Tris 150mmol/L, L-alanine 750 mmol/L, lactate dehydrogenase>1350 U/L, pH 7.3.

Reagent B: NADH 1.3mmol/L, 2-oxoglutarate 75mmol/L, sodium hydroxide 148 mmol/L, sodium azide 9.5 g/L. All reagents were stored at 4<sup>0</sup>C. Working reagent was prepared by mixing reagent A and B in 4:1 ratio just before the assay.

**Procedure:** The test tubes were labelled in a required manner. To every test tube, 1ml of working reagent was added. To the specified tube containing the reagent, a 50±1 sample was added and mixed well. After mixing, the initial absorbance was recorded and thereafter at 1 minute interval for 3 min. The average absorbance difference per minute and the amount of SGPT in the sample was calculated.

### 3.6.4 Economic

The economics of growing lamb farming will be studied from the data generated during the experiment by considering the market's prevailing feed and mutton costing. The cost of feeding for experimental lambs will be calculated from the records of daily feed consumption and by considering the price of feeds and fodder during the period of the experiment. The economics of growing lambs rearing will be compared based on feeding cost /kg body weight gain (Rs).

### 3.6.5 Statistical analysis

The data obtained about parameters under study will be subject to statistical analysis using Correlation analysis as per the Snedecor and Cochran, (1994) for interpretation of the results.

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# *Results & Discussion*

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## CHAPTER IV

### RESULTS AND DISCUSSION

The present research work entitled as "Effect of feeding Cactus (*Opuntia ficus*) on growth performance of Madgyal lambs" which was conducted on Eighteen experimental Madgyal lambs was carried out at "Madgyal lamb Unit" of Punyashlok Ahilyadevi Sheep and Goat Development Corporation, Dahiwadi, Dist- Satara (M.S) for the period of 90 days during August to November 20223.

In this experiment, different parameters were studied those are chemical analysis of feed, fortnightly body weight, daily body weight gain, hematological parameters like Hb, PCV, TEC count, TLC count, hematobiochemical parameters like SGOT, SGPT, Total Protein, Glucose, Albumin and economics of Feeding of cactus to Madgyal lambs. The economics of feeding Spineless Cactus (*Opuntia ficus*) was calculated according to parameters like feed intake, weight gain and present feed cost in the market. The data of the experiment were statistically analyzed for the interpretation of results. The data and observations recorded during the experiment and further discussed in this chapter.

#### 4.0 Chemical composition:

The chemical composition of Spineless cactus (*Opuntia ficus*) fed to the experimental Madgyal lambs presented in Table 4.1

The dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE), total ash (TA), neutral detergent fiber (NDF) and acid detergent fiber (ADF) content of Spineless cactus were 9.1, 70.6, 5.58, 1.01, 10.89, 53.22, 29.2, 38.6 and 27.25 percent respectively.

The chemical analysis of concentrate mixture, roughages and Cactus (*Opuntia ficus*) was carried out on dry matter basis (DMI) at the Department of Veterinary Biochemistry, Krantisinh Nana Patil College of Veterinary Science, Shirwal, Dist- Satara. (M.S).

**Table 4.1 Chemical composition (% DM) of Spineless Cactus (*Opuntia ficus*) fed to the Madgyal lambs**

Sr. No	Chemical composition	Cactus
1	DM	9.1
2	OM	70.6
<b>Proximate composition</b>		
3	CP	5.58
4	EE	1.01
5	CF	10.89
6	TA	29.19
7	NFE	53.22
<b>Van Soest fibre fractions</b>		
8	NDF	38.6
9	ADF	27.25

The CP content of the Spineless Cactus was 5.58 percent. The CP value for cactus obtained in this experiment was almost in agreement with the report of Ajith *et al.*, (2017). However, the values of CP content are in contrast with Ben Salem *et al.* (2002), Tegenge *et al.* (2005), Tien and Beynen (2005), Gebremariam *et al.* (2006) and Misra *et al.* (2006) who reported lower values of CP.

The NDF and ADF content in Spineless cactus were 38.6 and 27.25 respectively. Similar values were previously abborogated by Costa *et al.*, (2012), Gebremariam *et al.*, (2006), Misra *et al.*, (2006) and Viera *et al.*, (2008). While a range of 31 to 41 percent NDF has been reported by Costa *et al.*, (2016), Misra *et al.*, (2006) and Vieira *et al.*, (2008) However, lower values of NDF were reported by Tegenge *et al.*, (2007) and Ajith *et al.*, (2017). ADF content for cactus observed by Ajith *et al.* (2017) were lower than the cactus in the present study.

As per the present study TA content of Spineless cactus was 29.19 percent. Batisa *et al.*, (2003) observed the TA content of cactus was lower than the findings of present research work who observed the TA content in 10 varieties of cactus and reported a range of 10.4 to 13.3 percent. The higher TA content could be due to the age of the cladode (young cladode contain higher TA compared to middle-aged or old cladodes), and the soil content as reported by Retamal *et al.*, (1987).

#### **4.1 Growth performance**

Growth trial were conducted for 90 days on eighteen experimental Madgyal lambs to evaluate the effect of feeding Spineless Cactus (*Opuntia ficus*) on body weight, and average daily gain (ADG) under an intensive farming system.

##### **4.1.1 Fortnightly body weight (Kg)**

Throughout the 90 days of the experiment, the average body weight of the experimental lambs was measured on an electronic weighing balance every fortnightly. The average body weights of the control and treatment groups under the intensive farming system are presented in Table 4.2 and graphically depicted in Graph no-4.1.

Average initial body weight for groups control T0, 20 percent T1 and 40 percent T2 Spineless cactus along with concentrate mixture were  $17.33\pm 0.33$ ,  $17.33\pm 0.31$  and  $17.33\pm 0.21$ kg respectively with no significant difference in the groups and by the end of the sixth fortnight which grew linearly to  $22.03\pm 1.32$ ,  $21.96\pm 1.3$  and  $21.85\pm 1.27$ kg, respectively. Both the T0, T1 and T2 groups body weights displayed a linear increase during every fortnight interval. The differences between the three groups were non-significant which were revealed by Statistical data analysis during all fortnightly intervals. Relatively higher body weight was observed in the control (T0 group) as compared to T1 (20% Spineless cactus) and T2 (40% Spineless cactus) group lambs. Among the cactus-fed lambs, T1(20% Spineless cactus) had relatively higher body weight than the T2 (40% Spineless cactus) group, however, the differences were nonsignificant.

The sum of the mean values of average body weights for groups T0, T1 and T2, was calculated to be  $22.03\pm 1.32$  kg,  $21.96\pm 1.3$  kg and  $21.85\pm 1.27$  kg, respectively. Although the mean value of group T0 was numerically greater than that of groups T1 and T2, the difference was not statistically significant (Table 4.2). According to the present research findings, replacing the Spineless Cactus

(*Opuntia ficus*) with green roughages up to 20% and 40% levels could be done without any adverse effect on body weight in lambs.

The average fortnight body weight (Kg) are shown in Table.4.2 and graphically depicted in Graph no-4.1.

**Table 4.2 Average Mean  $\pm$  SE values of fortnight body weight (Kg) in experimental Madgyal lambs**

Fortnights	Treatment groups				Significance
	T0	T1	T2	P-value	
<b>0 Day</b>	17.33 $\pm$ 0.33	17.33 $\pm$ 0.31	17.33 $\pm$ 0.21	1	NS
<b>1</b>	18.85 $\pm$ 0.3	18.81 $\pm$ 0.29	18.78 $\pm$ 0.20	0.986	NS
<b>2</b>	20.35 $\pm$ 0.27	20.29 $\pm$ 0.29	20.23 $\pm$ 0.20	0.952	NS
<b>3</b>	21.85 $\pm$ 0.24	21.77 $\pm$ 0.27	21.69 $\pm$ 0.20	0.900	NS
<b>4</b>	23.55 $\pm$ 0.21	23.45 $\pm$ 0.26	23.30 $\pm$ 0.22	0.766	NS
<b>5</b>	25.21 $\pm$ 0.19	25.12 $\pm$ 0.27	24.95 $\pm$ 0.21	0.721	NS
<b>6</b>	27.13 $\pm$ 0.18	27 $\pm$ 0.26	26.73 $\pm$ 0.23	0.483	NS
<b>Mean<math>\pm</math>S.E</b>	22.03 $\pm$ 1.32	21.96 $\pm$ 1.3	21.85 $\pm$ 1.27	0.995	NS

**P-value:** Probability value ( $P \geq 0.05$ ), **NS-** Non-significant

The present study shows that the control group (T0) had higher weight gain than the treatment groups (T1, T2) which shows statistically non-significant differences between the control and treatment groups on fortnightly body weight gains. The current results are in agreement with those of Shashi Kumar *et al.*, (2017) in Mandya lambs and also similar results were observed with Shrutaliya *et al.*, (2022) in Nellore lambs who also observed non-significant differences between experimental groups. Also similar findings were found with Sirohi *et al.*, (1997), Terblanche *et al.*, (1971), Nefzaoui *et al.*, (2001), Salem *et al.*, (2002), Atti *et al.*, (2006) all these observed that there is a negative correlation in body

weight by inclusion of cactus in ration which showed non-significant differences between the experimental groups.

However, the results of the current study are in contrast with Gebremaram *et al.*, (2006) who reported that the lambs fed with Spineless Cactus (*Opuntia ficus*) shows higher weight gain than the control groups. This shows that the cactus fed groups observed significant increase in weight gain of lambs. Also, there were positive correlation on body weight with the inclusion of cactus by Mcdonal *et al.*, (2002), Islam *et al.*, (2017) and Kauthale *et al.*, (2017) which had a significant effect on weight gain of experimental groups.

#### **4.1.2 Average daily gain (g)**

The average daily gain in body weight along each fortnight interval was calculated using the difference between body weights from the previous and current fortnights by dividing the no. of days fed.

Madgyal lambs in T0, T1 and T2 group had an average daily gain (g) of  $102.9 \pm 2.24$ ,  $98.6 \pm 1.95$  and  $97.5 \pm 0.88$  g, respectively during 90 days of the experimental period and the differences were non-significant revealed according to statistical data analysis. Among the cactus-fed lambs, comparably higher ADG was observed in T0 as compared to treatment groups however among treatment groups T1(20% Spineless cactus) has higher ADG as compared to T2 (40% Spineless cactus).

The average daily gain of lambs in different treatment groups was 110, 109, and 108 gm for T0, T1, and T2 respectively. Thus it was observed that control groups had observed higher daily gain as compared to cactus-fed groups (T1, T2).

The results of the current study, are corroborated by the results of Shashi Kumar *et al.*, (2017), who showed that feeding Spineless cactus to growing lambs had no significant effects on average daily body weight gain. Additionally, Shrutaliya *et al.*, (2022) found a non-significant impact of giving Spineless cactus on the growth performance of Nellore lambs. Mendez-llorente *et al.*, (2011),

Costa *et al.*, (2012), Knupp *et al.*, (2019) also observed there was a non-significant effect of inclusion of cactus on average daily gain which was lower in treatment group as compared to control groups.

However, the current findings were in contrast with Gebremaram *et al.*, (2006) who observed a significant increase in body weight gain with increased levels of cactus intake in growing lambs. Inclusion of Spineless cactus had positive correlation with average daily gain also observed by Mengistu *et al.*, (2016), Islam *et al.*, (2017) and Kauthale *et al.*, (2017).

The data collected is presented in Table 4.3 and graphically depicted in Graph No. 4.2

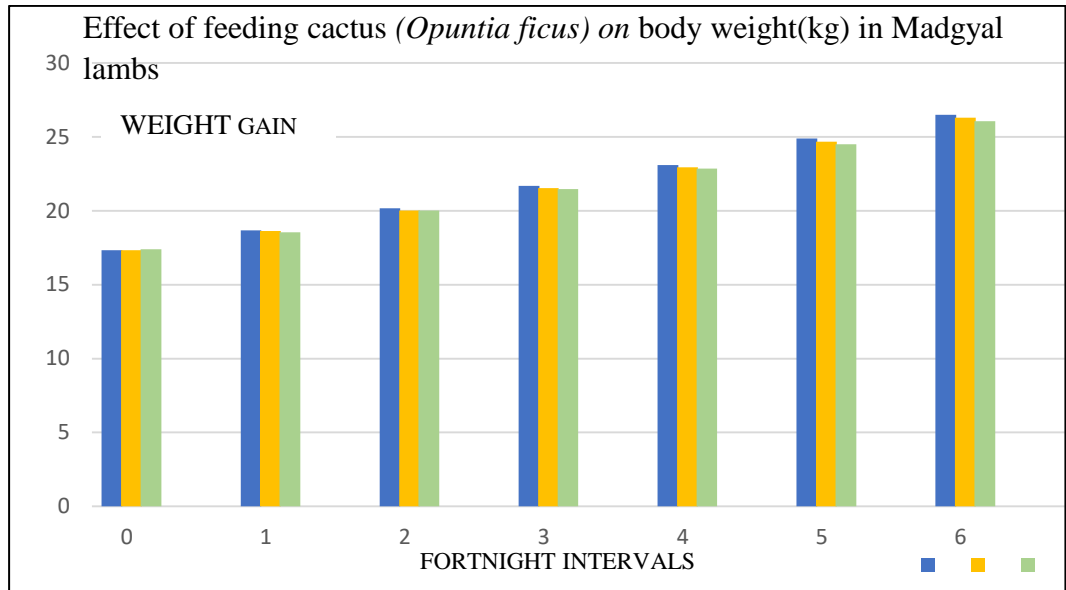
**Table 4.3 Average Mean  $\pm$  SE daily body weight gain (gm/head/day) in experimental Madgyal lambs.**

Fortnights	Treatment groups				Significance
	T0	T1	T2	P-value	
1	102.9 $\pm$ 2.24	98.6 $\pm$ 1.95	97.5 $\pm$ 0.88	0.110	NS
2	99.3 $\pm$ 1.57	98.6 $\pm$ 1.38	97.7 $\pm$ 0.73	0.698	NS
3	103.9 $\pm$ 1.27	105.08 $\pm$ 0.39	104.8 $\pm$ 0.62	0.630	NS
4	118.9 $\pm$ 1.63	114.6 $\pm$ 1.71	114.8 $\pm$ 1.49	0.139	NS
5	111.6 $\pm$ 1.41	111.5 $\pm$ 0.24	111.08 $\pm$ 0.83	0.911	NS
6	124.4 $\pm$ 1.39	125.7 $\pm$ 0.40	125.06 $\pm$ 0.80	0.633	NS
<b>Mean<math>\pm</math>S.E</b>	110.07 $\pm$ 4.04	109.01 $\pm$ 4.27	108.49 $\pm$ 4.36	0.964	NS

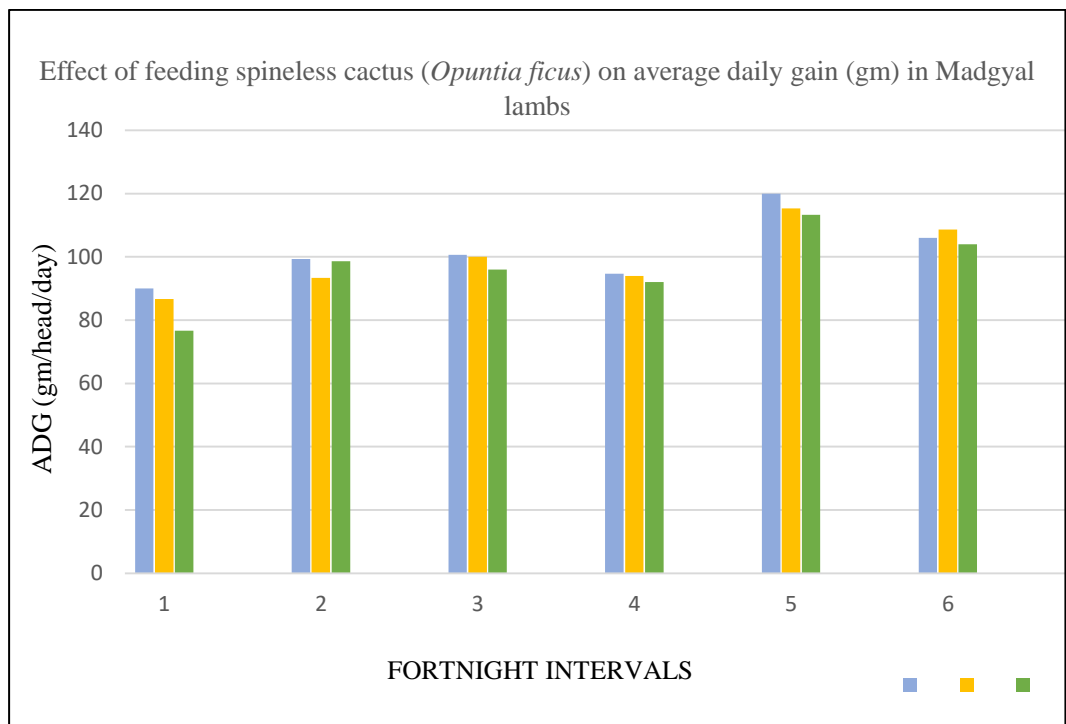
**P-value:** Probability value ( $P \geq 0.05$ ), **NS-** Non-significant

#### 4.2 Haematological parameters

The haematological tests of the current experimental study were conducted on the 0<sup>th</sup>, 30<sup>th</sup>, 60<sup>th</sup>, and 90<sup>th</sup> days of the experiment i.e. every month.



Graph 4.1 Effect of feeding Spineless cactus (*Opuntia ficus*) on body weight (kg) in Madgyal lambs



Graph 4.2 Effect of feeding Spineless cactus (*Opuntia ficus*) on average daily gain (g) in Madgyal lambs

#### 4.2.1 Haemoglobin (gm/dl)

Magyal lambs in T0, T1, T2 groups had mean initial estimated haemoglobin values were  $10\pm 0.19$ ,  $10.08\pm 0.48$ , and  $10.05\pm 0.24$  g/dl respectively while the final hemoglobin values were  $9.93\pm 0.23$ ,  $9.85\pm 0.13$ ,  $9.75\pm 0.22$  g/dl respectively at the end of the 90-day experiment. During the 90 days of the experiment non-significant ( $P < 0.05$ ) differences were observed among T0, T1 and T2 in haemoglobin values among all three experimental groups. Relatively higher Hb values were observed in T0 as compared to T1 and T2 group lambs at the end of the experiment. However, the haemoglobin values among all the three experimental group lambs were within the normal physiological range.

The mean values of haemoglobin concentration (gm/dl) in experimental groups are shown in Table 4.4 and graphically depicted in Graph no 4.3.

**Table: 4.4 Haemoglobin concentration (gm/dl) in experimental Madgyal lambs.**

Monthly	Treatment groups				Significance
	T0	T1	T2	P-value	
<b>0 Day</b>	$10\pm 0.19$	$10.08\pm 0.48$	$10.05\pm 0.24$	0.984	NS
<b>1</b>	$9.81\pm 0.29$	$9.88\pm 0.24$	$9.68\pm 0.17$	0.840	NS
<b>2</b>	$10.2\pm 0.31$	$10.01\pm 0.26$	$9.81\pm 0.12$	0.566	NS
<b>3</b>	$9.93\pm 0.23$	$9.85\pm 0.13$	$9.75\pm 0.22$	0.817	NS
<b>Mean±S.E</b>	$9.98\pm 0.08$	$9.95\pm 0.05$	$9.82\pm 0.08$	0.297	NS

**P-value:** Probability value ( $P \geq 0.05$ ), **NS-** Non-significant

The findings of the present study, were in agreement with Morshedy *et al.* (2020) who observed that, there was no statistically significant difference in Hb values between lambs fed diets supplemented with two levels of prickly pear cactus (*Opuntia ficus-indica*) peels. Also, Shrutaliya *et al.*, (2022) observed that,

non-significant effect on Hb values in Nellore lambs who also observed higher Hb values in control group as compared to treatment groups.

#### 4.2.2 Packed cell volume (PCV %)

Magyal lambs in T0, T1, T2 groups had mean initial estimated PCV values were 31.83±0.94, 31.83±1.01, 31.63±0.98 % respectively while the final PCV values were 32.83±1.24, 33.16±0.70, 31.66±1.11 g/dl respectively at the end of the 90-day experiment.

The overall mean of PCV (%) values were 32.66±0.67, 32.70±0.31 and 32.19±0.35 percent in T0, T1 and T2 groups, respectively. It is observed that, the values of PCV (%) were statistically non-significant in the present study. The different inclusion levels of Cactus (*Opuntia ficus*) in a ration had a non-significant effect on PCV concentration in the blood. The treatment diets were to be nutritional and non-toxic and seemed to have influenced an adequate blood supply based on the normal PCV levels obtained in this experiment.

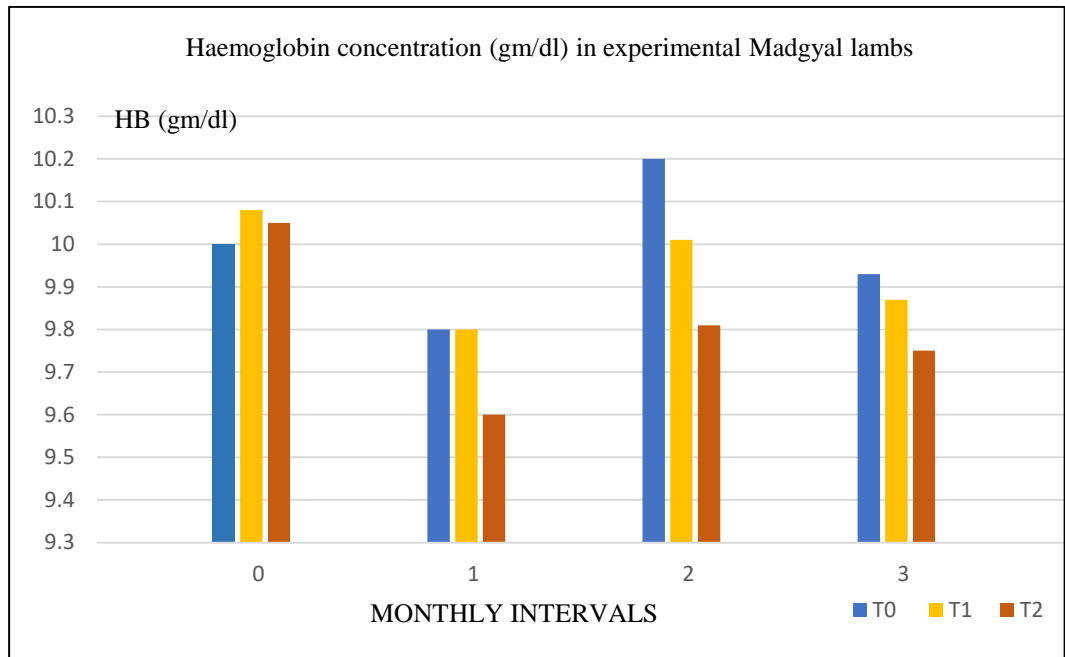
The values of packed cell volume (PCV%) of experimental animals are shown in Table 4.5 and graphically depicted in Graph 4.4.

**Table:4.5 Average PCV (%) values in experimental Madgyal lambs.**

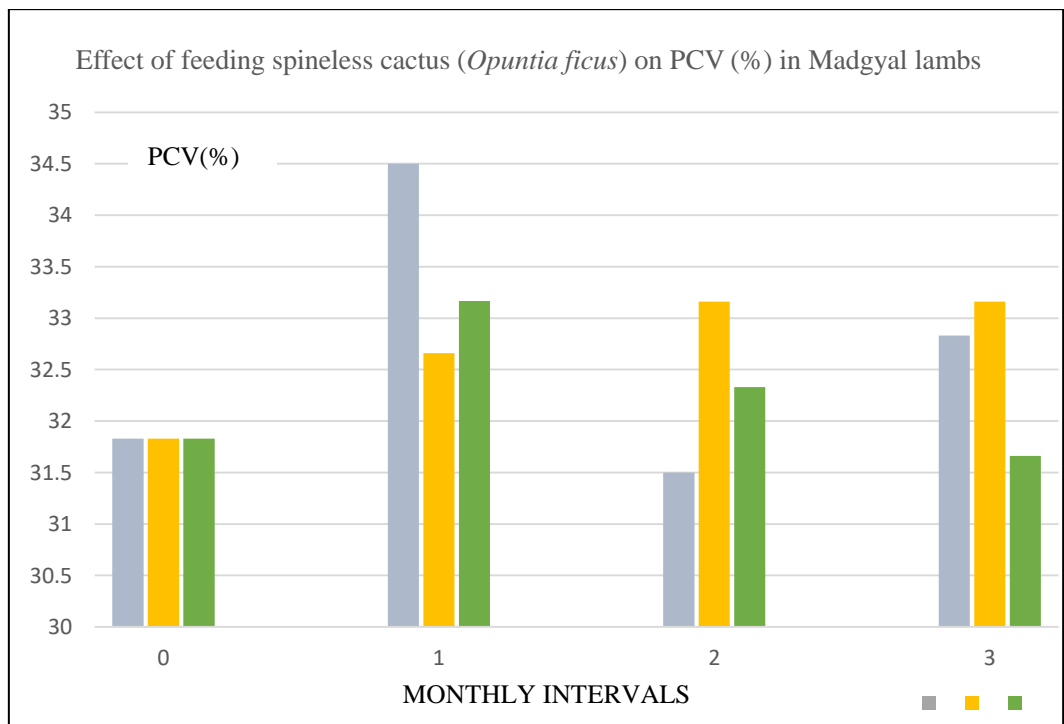
Monthly	Treatment groups				Significance
	T0	T1	T2	P-value	
<b>0 Day</b>	31.83±0.94	31.83±1.01	31.63±0.98	0.987	NS
<b>1</b>	34.50±1.43	32.66±1.14	33.16±1.42	0.616	NS
<b>2</b>	31.50±.0921	33.16±1.19	32.33±1.25	0.593	NS
<b>3</b>	32.83±1.24	33.16±0.70	31.66±1.11	0.581	NS
<b>Mean±S.E</b>	32.66±0.67	32.70±0.31	32.19±0.35	0.713	NS

**P-value:** Probability value ( $P \geq 0.05$ ), **PCV (%)**, **NS-** Non-significant

The current research findings are similar to Morshedy *et al.*, (2020) who observed that, the replacement of the green roughages with prickly pear cactus did



Graph 4.3 Effect of feeding Spineless cactus (*Opuntia ficus*) on haemoglobin (gm/dl) in Madgyal lambs



Graph 4.4 Effect of feeding Spineless cactus (*Opuntia ficus-indica*) on PCV (%) in Madgyal lambs

not significantly affect the PCV values of growing lambs. Also similar findings were observed in Shrutaliya *et al.*, (2022) non-significant change in PCV values in lambs fed on Cactus (*Opuntia ficus*).

#### 4.2.3 Total leucocyte count (TLC) ( $\times 10^3/\mu\text{L}$ )

During the experiment period of 90 days on Madgyal lambs in T0, T1, T2 groups had mean initial estimated TLC values were  $5.06\pm 0.41$ ,  $5.03\pm 0.39$ ,  $5.25\pm 0.51$  ( $\times 10^3/\mu\text{L}$ ) respectively while the final TLC values were  $5.38\pm 0.52$ ,  $5.41\pm 0.47$ ,  $5.26\pm 0.47$  ( $\times 10^3/\mu\text{L}$ ) respectively at the end of the 90-day experiment.

The overall mean of TLC ( $\times 10^3/\mu\text{L}$ ) values were  $5.44\pm 0.18$ ,  $5.49\pm 0.18$  and  $5.51\pm 0.15$  ( $\times 10^3/\mu\text{L}$ ) in T0, T1 and T2 groups, respectively. It is indicated that, the values of TLC ( $\times 10^3/\mu\text{L}$ ) were statistically non-significant in the present study. The different inclusion levels of Cactus (*Opuntia ficus*) in a ration have non-significant effect on TLC concentration in the blood. So, there was no adverse effect of Cactus (*Opuntia ficus*) on the blood TLC and the normal values of WBC obtained in this study suggested well-developed immune systems of the lambs in different dietary groups.

The average values of the total leucocyte count (TLC) of experimental animals are shown in Table 4.6 and graphically depicted in Graph no. 4.5.

**Table:4.6 Average TLC ( $\times 10^3/\mu\text{L}$ ) in experimental Madgyal lambs.**

Monthly	Treatment groups				Significance
	T0	T1	T2	P-value	
<b>0 Day</b>	$5.06\pm 0.41$	$5.03\pm 0.39$	$5.25\pm 0.51$	0.934	NS
<b>1</b>	$5.4\pm 0.46$	$5.93\pm 0.43$	$5.73\pm 0.25$	0.581	NS
<b>2</b>	$5.95\pm 0.93$	$5.6\pm 0.27$	$5.83\pm 0.30$	0.742	NS
<b>3</b>	$5.38\pm 0.52$	$5.41\pm 0.47$	$5.26\pm 0.47$	0.975	NS
<b>Mean<math>\pm</math>S.E</b>	$5.44\pm 0.18$	$5.49\pm 0.18$	$5.51\pm 0.15$	0.960	NS

**P-value:** Probability value ( $P\geq 0.05$ ), **TLC** ( $\times 10^3/\mu\text{L}$ ), **NS-** Non-significant

The current findings in this study are in agreement with Morshedy *et al.*, (2020) reported non-significant change in TLC in sheep fed on prickly pear cactus. Also the similar findings were observed with Shrutaliya *et al.*, (2022) who reported that non-significant changes TLC values by feeding chopped Spineless cactus.

#### 4.2.4 Total erythrocyte count (TEC) ( $\times 10^6/\mu\text{L}$ )

Madgyal lambs in T0, T1, T2 groups had mean initial estimated TEC values were  $11.31\pm 0.60$ ,  $10.31\pm 0.65$ ,  $11.08\pm 0.68$  ( $\times 10^6/\mu\text{L}$ ) respectively while the final TEC values were  $11.93\pm 0.69$ ,  $11.35\pm 0.42$ ,  $12.08\pm 0.85$  ( $\times 10^6/\mu\text{L}$ ) respectively at the end of the 90-day experiment.

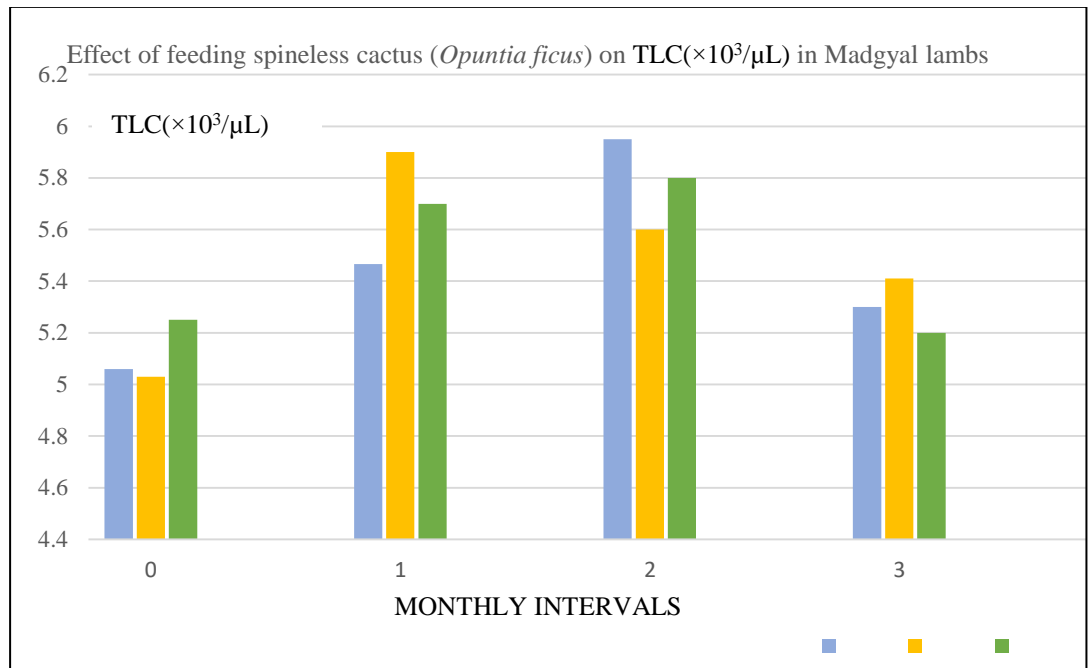
The overall mean of TEC ( $\times 10^6/\mu\text{L}$ ) values were  $12.06\pm 0.29$ ,  $11.31\pm 0.40$  and  $11.83\pm 0.39$ , ( $\times 10^6/\mu\text{L}$ ) in T0, T1 and T2 groups, respectively. It is observed that, the values of TEC ( $\times 10^6/\mu\text{L}$ ) were statistically non-significant in the present study. The different inclusion levels of Spineless cactus (*Opuntia ficus*) in a ration have a non-significant effect on TEC concentration in the blood. So, there was not having any adverse effect of Spineless cactus (*Opuntia ficus*) on the blood TEC.

The average values of the total erythrocyte count (TEC) of experimental animals are shown in Table 4.7 and graphically depicted in Graph No. 4.6.

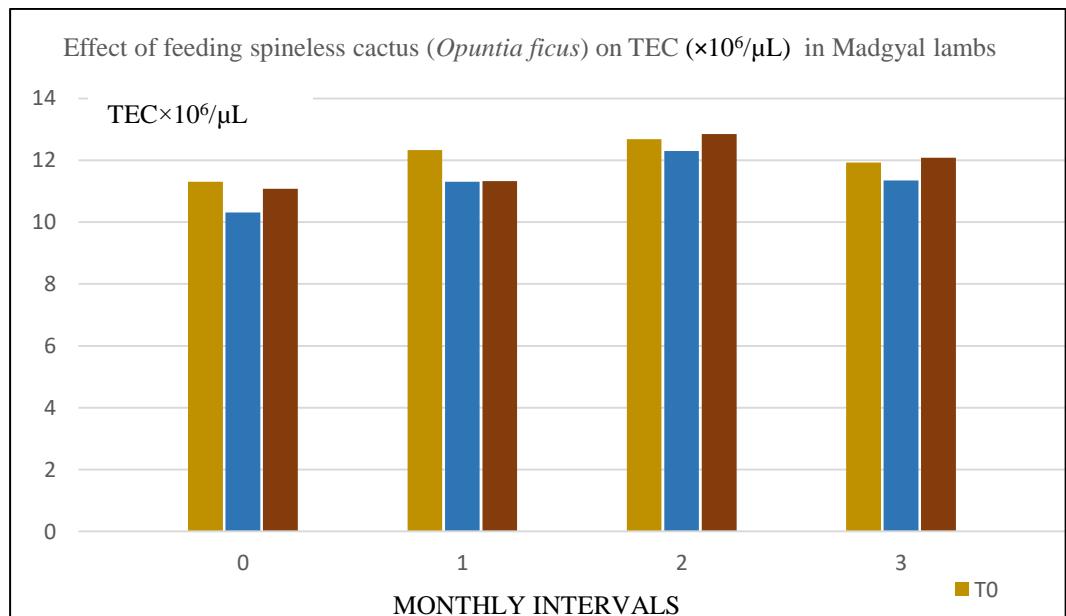
**Table 4.7 Average TEC ( $\times 10^6/\mu\text{L}$ ) in experimental Madgyal lambs.**

Monthly	Treatment groups				Significance
	T0	T1	T2	P-value	
0 Day	$11.31\pm 0.60$	$10.31\pm 0.65$	$11.08\pm 0.68$	0.535	NS
1	$12.33\pm 0.33$	$11.31\pm 0.56$	$11.33\pm 1.02$	0.451	NS
2	$12.68\pm 0.34$	$12.30\pm 0.57$	$12.85\pm 0.59$	0.647	NS
3	$11.93\pm 0.69$	$11.35\pm 0.42$	$12.08\pm 0.85$	0.728	NS
Mean $\pm$ S.E	$12.06\pm 0.29$	$11.31\pm 0.40$	$11.83\pm 0.39$	0.385	NS

**P-value:** Probability value ( $P\geq 0.05$ ), **TEC** ( $\times 10^6/\mu\text{L}$ ), **NS-** Non-significant



Graph 4.5 Effect of feeding Spineless cactus (*Opuntia ficus*) on TLC( $\times 10^3/\mu\text{L}$ ) in Madgyal lambs



Graph 4.6 Effect of feeding Spineless cactus (*Opuntia ficus*) on TEC ( $\times 10^6/\mu\text{L}$ ) in Madgyal lambs

The present findings in this study are in agreement with Morshedy *et al.*, (2020) reported a non-significant change in TEC in sheep fed on prickly pear cactus. Also similar findings were observed with Shrutaliya *et al.*, (2022) who reported non-significant changes in TEC values by feeding chopped Spineless cactus.

### 4.3 Biochemical parameters

#### 4.3.1 Serum Glucose (mg/dl)

The serum glucose concentration (mg/dl) before the start of experiment in growing Madgyal lambs in different experimental groups T0, T1 and T2 was 55.16±1.62, 54.83±1.42 and 56.83±1.40 fed with or without Spineless cactus (*Opuntia ficus*). While at the end of the experiment, serum glucose concentration (mg/dl) of 68.66±1.14, 65.58±3.59 and 67.29±3.50 were observed in T0, T1 and T2 groups, respectively (Table 4.22 and Graph 4.20). The results revealed that, the supplementation of Spineless cactus (*Opuntia ficus*) in the diet showed no significant difference among three experimental group lambs. The concentration of serum glucose (mg/dl) was relatively higher in T1 and T2 as compared with T0 group lambs.

The average values of Glucose (mg/dl) of experimental animals are shown in Table 4.8 and graphically depicted in Graph No. 4.7.

**Table:4.8 Average Glucose values (mg/dl) in experimental Madgyal lambs.**

Monthly	Treatment groups				Significance
	T0	T1	T2	P-value	
0 Day	55.16±1.62	54.83±1.42	56.83±1.40	0.605	NS
1	68.83±0.70	68.33±1.74	69.83±0.60	0.647	NS
2	68.33±0.71	69.33±1.05	71±0.96	0.153	NS
3	68.66±1.14	69.83±1.53	71.50±0.84	0.280	NS
Mean±S.E	65.24±3.36	65.58±3.59	67.29±3.50	0.907	NS

**P-value:** Probability value ( $P \geq 0.05$ ), **AST (IU/L)**, **NS-** Non-significant

The present findings in this study are in agreement with Morshedy *et al.*, (2020) reported a non-significant change in Serum glucose in sheep fed on prickly pear cactus. Also similar findings were observed with Shrutaliya *et al.*, (2022) who reported non-significant changes in glucose values by feeding chopped Spineless cactus in which treatment groups had higher glucose levels than the control group. Which shows a non-significant linear increase in glucose values of lambs fed with cactus. Also, non-significant increase in values of glucose were observed with Cardoso *et al.*, (2019) and Silva *et al.*, (2023).

#### 4.3.2 Total Protein (g/dl)

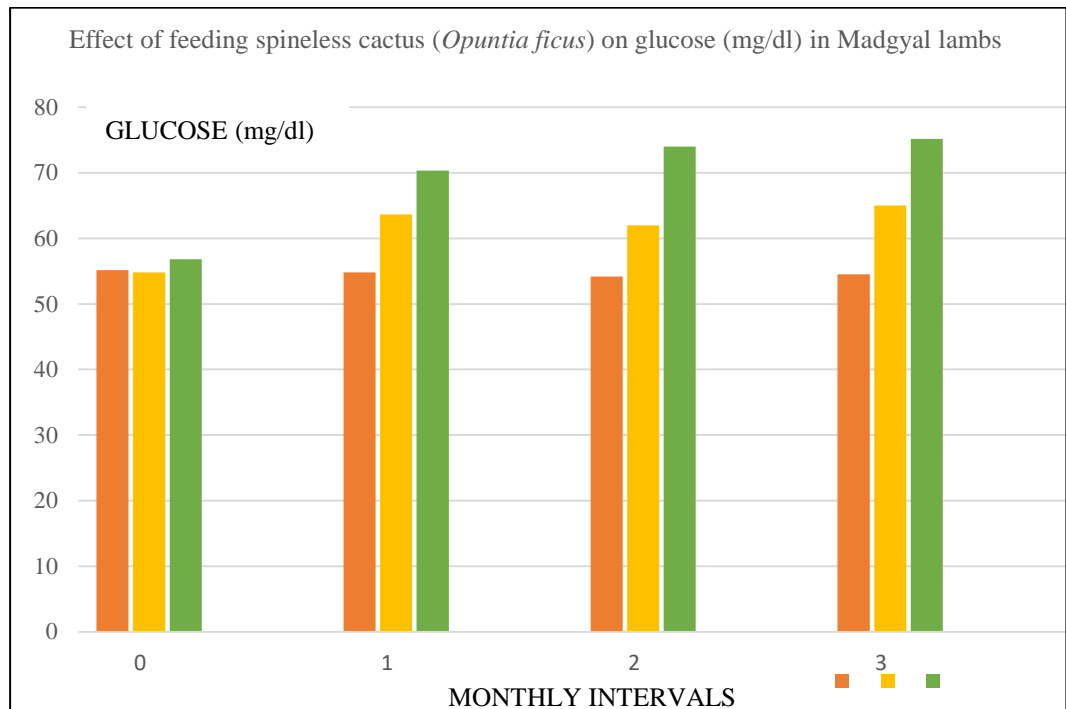
The mean values of Total protein concentration (g/dl) in T0, T1 and T2 experimental Madgyal lamb groups before the start of the experiment were 6.5±0.18, 6.58±0.24 and 6.73±0.21 thereof at the end of the experiment were 6.95±0.08, 6.67±0.20 and 6.60±0.15, respectively (Table 4.9 and Graph 4.8). Total protein concentration (g/dl) was non-significant (P<0.05) among three different experimental group lambs. The results observed that, the supplementation of Spineless cactus (*Opuntia ficus*) in the diet showed no significant difference among three experimental group lambs.

The average values of Total Protein (g/dl) of experimental animals are shown in Table 4.9 and graphically depicted in Graph No. 4.8.

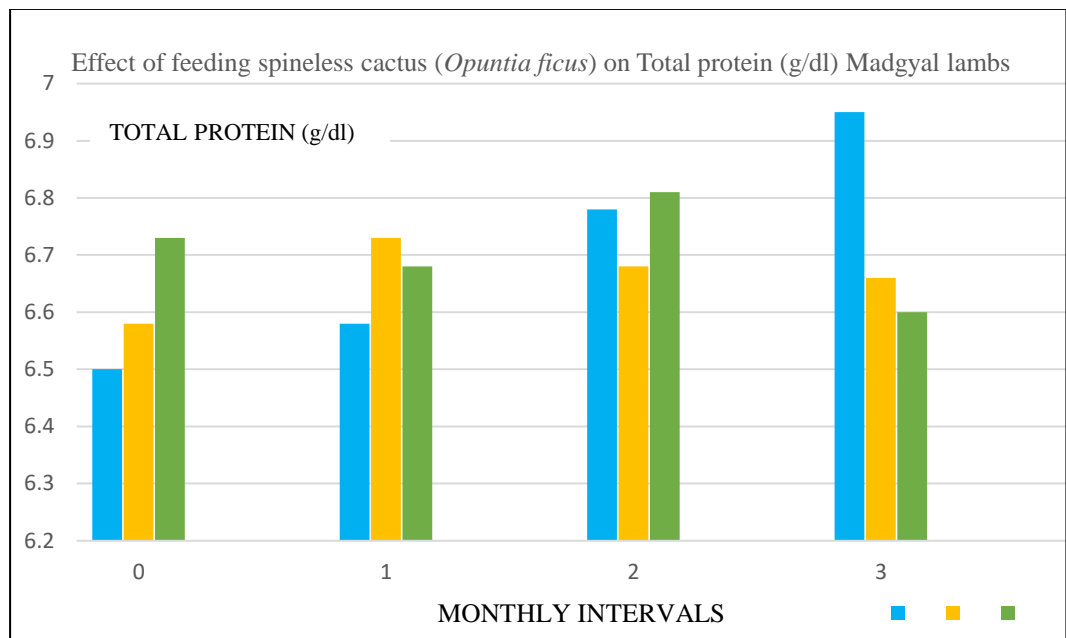
**Table:4.9 Average Total Protein values (g/dl) in experimental Madgyal lambs.**

Monthly	Treatment groups				Significance
	T0	T1	T2	P-value	
<b>0 Day</b>	6.5±0.18	6.58±0.24	6.73±0.21	0.743	NS
<b>1</b>	6.58±0.26	6.73±0.26	6.68±0.25	0.919	NS
<b>2</b>	6.78±0.19	6.68±0.24	6.81±0.27	0.920	NS
<b>3</b>	6.95±0.08	6.67±0.20	6.60±0.15	0.275	NS
<b>Mean±S.E</b>	6.70±0.10	6.66±0.031	6.70±0.044	0.893	NS

**P-value:** Probability value (P≥0.05), **AST (IU/L)**, **NS-** Non-significant



Graph 4.7 Effect of feeding Spineless cactus (*Opuntia ficus*) on glucose (mg/dl) in Madgyal lambs



Graph 4.8 Effect of feeding Spineless cactus (*Opuntia ficus*) on Total protein (g/dl) in Madgyal lambs

The present research has been observed in agreement with Morshedy *et al.*, (2020) who observed the non-significant differences between the values of TP in different experimental groups.

However, the recent research work was in contrast with the work of Shrutaliya *et al.*, (2022) who observed a significant increase in values of TP as increased inclusion of Spineless cactus in treatment groups that is T1 and T2. Also, the similar findings were found in Alhanafi *et al.*, (2019) who observed a significant increase in values of TP as increased inclusion of Spineless cactus in treatment groups that is T1 and T2

#### **4.3.3 Serum Albumin (g/dl)**

In Madgyal lambs of different experimental groups T0, T1 and T2, before the start of the experiment had a mean serum albumin concentration (g/dl) of  $2.50 \pm 0.11$ ,  $2.53 \pm 0.16$  and  $2.65 \pm 0.11$  while at the end of the experiment were  $2.55 \pm 0.08$ ,  $2.65 \pm 0.18$  and  $2.91 \pm 0.19$ , respectively (Table 4.10 and Graph 4.9). Statistical analysis of the data at the end of the experiment revealed a non-significant difference in serum albumin among the three experimental groups. The mean serum albumin levels of Madgyal lambs were relatively higher in T1 and T2 groups than in control group lambs, however, the values are within the normal physiological range.

The data collected is presented in Table 4.10 and graphically depicted in Graph No. 4.9

**Table:4.10 Average Serum Albumin values (g/dl) in experimental Madgyal lambs.**

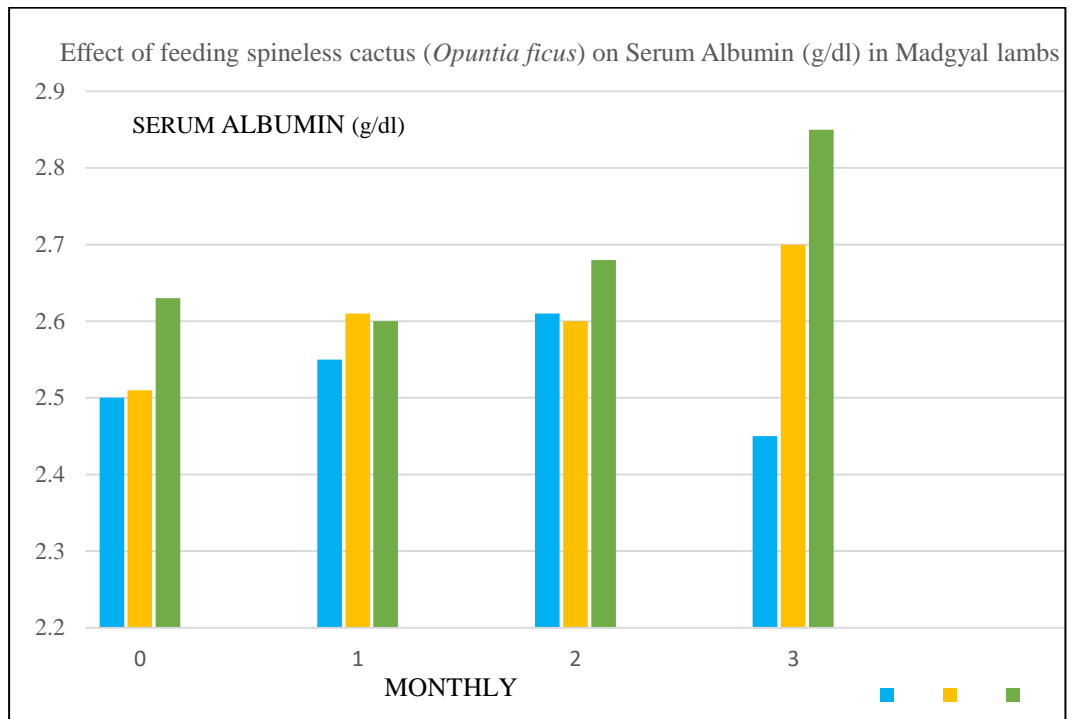
Monthly	Treatment groups				Significance
	T0	T1	T2	P-value	
<b>0 Day</b>	2.50±0.11	2.53±0.16	2.65±0.11	0.719	NS
<b>1</b>	2.71±0.18	2.73±0.11	2.6±0.1	0.765	NS
<b>2</b>	2.75±0.1	2,6±0.13	2.78±0.08	0.483	NS
<b>3</b>	2.55±0.08	2.65±0.18	2.91±0.19	0.284	NS
<b>Mean±S.E</b>	2.60±0.06	2.62±0.04	2.73±0.06	0.367	NS

**P-value:** Probability value ( $P \geq 0.05$ ), **NS-** Non-significant

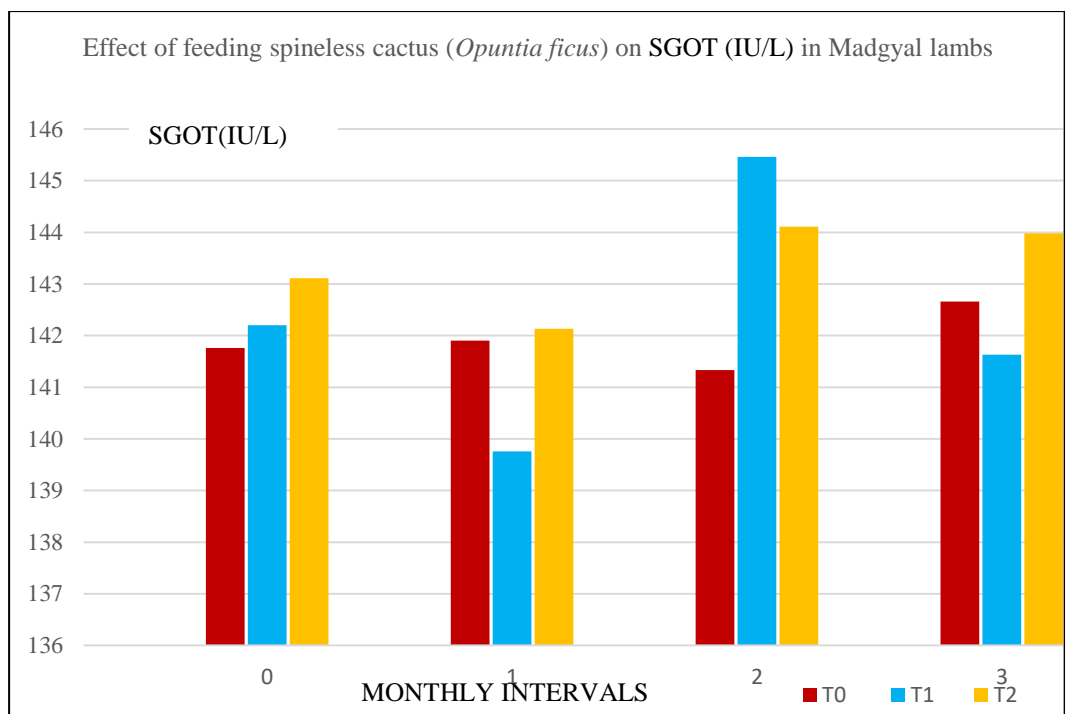
The results of the current study, are corroborated by Morshedy *et al.*, (2020) who observed non-significant differences between the values of Albumin in different experimental groups. Similar findings were observed with Shrutaliya *et al.*, (2022) who observed a non-significant variation among the values of Albumin who fed cactus in replacement of Super Napier up to 20 and 40% for 75 days in Nellore Lambs.

#### **4.3.4 Serum Glutamic Oxaloacetic Transaminase (SGOT)**

In the current study, serum glutamic oxaloacetic transaminase (SGOT) (IU/L) was estimated by using a semi-auto analyzer at monthly intervals. The average SGOT values of experimental animals are shown in Table.4.11 and graphically depicted in Graph no-4.10. The average values of SGOT enzyme at the start of experiment for the T0, T1 and T2 groups were found to be 141.76±5.19, 142.20±11.68 and 143.11±11.80 IU/L, respectively while at 90 days of experiment, it was found to be 142.66±9.9 IU/L for T0 group, 145.46±11.48 IU/L for T1 group and 143.98±9.64 IU/L for T2 group. The overall mean values of SGOT enzyme for the T0, T1 and T2 groups were calculated to be 141.86±0.31, 141.48±1.53 and 143.33±0.45 IU/L, respectively which differed non-significantly from each other (Table 4.11). The results revealed that the



Graph 4.9 Effect of feeding Spineless cactus (*Opuntia ficus*) on Albumin (g/dl) in Madgyal lambs



Graph 4.10 Effect of feeding Spineless cactus (*Opuntia ficus*) on SGOT (IU/L) in Madgyal lambs

supplementation of Spineless cactus (*Opuntia ficus*) in the diet showed no significant difference in serum enzyme SGOT levels when the lambs were fed with experimental diets.

The average values of SGOT (IU/L) of experimental animals are shown in Table 4.11 and graphically depicted in Graph No. 4.10.

**Table:4.11 Average (SGOT) values (IU/L) in experimental Madgyal lambs.**

Monthly	Treatment groups				Significance
	T0	T1	T2	P-value	
<b>0 Day</b>	141.76±5.19	142.20±11.68	143.11±11.80	0.995	NS
<b>1</b>	141.90±3.0	138.51±6.8	142.13±13.27	0.949	NS
<b>2</b>	141.13±11.59	139.76±11.27	144.11±9.4	0.959	NS
<b>3</b>	142.66±9.9	145.46±11.48	143.98±9.64	0.982	NS
<b>Mean±S.E</b>	141.86±0.31	141.48±1.53	143.33±0.45	0.380	NS

**P-value:** Probability value ( $P \geq 0.05$ ), **SGOT (IU/L)**, **NS-** Non-significant

The results obtained in the present study are in accordance with the findings Shrutaliya *et al.*, (2022) and Morshedy *et al.*, (2020) who observed liver function tests (SGOT concentrations) before start of the experiment and at the end of the experiment were comparable among the three experimental group lambs. All these indicating, spineless cactus does not contain any toxic substances which can harm liver.

They also reported the non-significant effect of cactus supplementation on serum SGOT enzyme levels.

#### **4.3.5 Serum Glutamic Pyruvic Transaminase (SGPT)**

In the present study, of feeding Spineless cactus (*Opuntia ficus*) for Madgyal lambs Serum Glutamic Pyruvic Transaminase (SGPT) was estimated by using a semi-auto analyzer at monthly intervals.

The mean values of SGPT among all experimental groups were 28.21±1.33, 27.64±2.52 and 27.73±0.44. While at the end of experiment, it was found to be 29.71±1.27 IU/L for T0 group, 28.90±0.48 IU/L for T1 group and 29.63±1.28 IU/L for T2 group. The overall mean values of SGPT enzyme for the T0, T1 and T2 groups were calculated to be 30.08±0.74, 29.25±0.62 and 29.40±0.57 IU/L, respectively which differed non-significantly from each other (Table 4.12). The results revealed that, the supplementation of Spineless cactus (*Opuntia ficus*) in the diet had no significant difference was observed for serum enzyme SGPT levels among the three experimental group lambs.

The average SGPT values (IU/L) are shown in Table.4.12 and graphically depicted in Graph no-4.11.

**Table:4.12 Average (SGPT) (IU/L) values in experimental Madgyal lambs.**

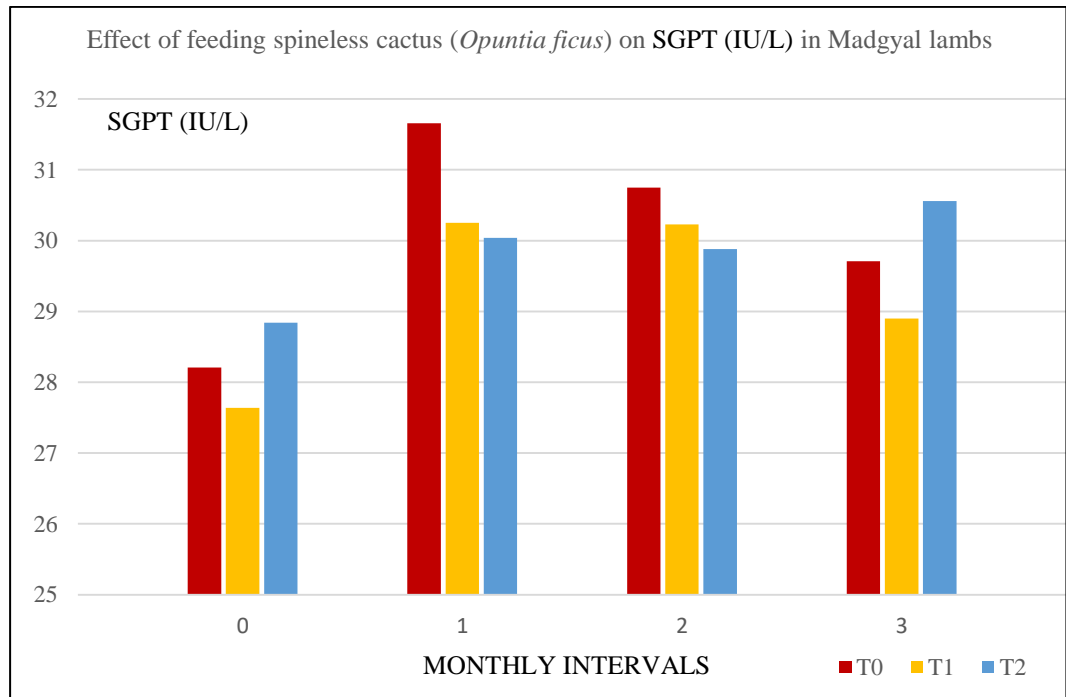
Monthly	Treatment groups				Significance
	T0	T1	T2	P-value	
<b>0 Day</b>	28.21±1.33	27.64±2.52	27.73±0.44	0.967	NS
<b>1</b>	31.66±1.48	30.25±1.52	30.06±2.12	0.778	NS
<b>2</b>	30.75±2.09	30.23±1.68	30.20±0.87	0.965	NS
<b>3</b>	29.71±1.27	28.90±0.48	29.63±1.28	0.843	NS
<b>Mean±S.E</b>	30.08±0.74	29.25±0.62	29.40±0.57	0.645	NS

**P-value:** Probability value ( $P \geq 0.05$ ), (SGPT) (IU/L), **NS-** Non-significant

These results in the present study are also supported by the findings Morshedy *et al.*, (2020) and Shrutaliya *et al.*, (2022) who observed non-significant differences among the values of SGPT in all three experimental groups. Also reported that the inclusion of Spineless cactus in the diet of lambs did not any adverse effect on the liver.

### **1.7 Economics of the Madgyal lambs feeding**

The total cost of feed in T0, T1 and T2 group experimental lambs was Rs. 17.24, Rs. 16.76 and Rs. 16.28. It shows that the total feed cost was low in T2



Graph 4.11 Effect of feeding Spineless cactus (*Opuntia ficus*) on SGPT (IU/L) in Madgyal lambs

group. Whereas, the cost of feed per Kg body weight gain in Madgyal lambs fed with experimental diets was Rs. 109.17, Rs. 103.08 and Rs. 95.69 for T0, T1 and T2 groups respectively. There was no significant difference between the three groups in cost of production.

The data obtained during the experiment was used for analyzing the economics of feeding the experimental Madgyal lambs, taking into consideration the current market feed price about body weight gain. The cost of feeding experimental lambs was determined proportionately to the increase in body weight throughout the experimental period based on records of daily feed consumed and the market price of feed during that time.

According to the present study, farmers benefited from Spineless cactus (*Opuntia ficus*) at replacement rates of 20% and 40% for green roughages. In the present study, experimental lambs fed on Spineless cactus (*Opuntia ficus*) had decreased weight gain as compared to the control group, however, this difference was not statistically significant.

The feeding cost per kg weight gain was 187, 184 and 183 Rs for T0, T1 and T2 groups, respectively. The feeding cost per Kg weight gain was lower in the T2 group than T1 group and further T1 group are lower than the T0 group. From the present study, it can be concluded that, feeding Spineless cactus (*Opuntia ficus*) in the diet of Madgyal lambs is economical for the farmers as it lowers the feeding cost per animal.

The findings in the present study agree with Grunwaldt *et al.*, (2015) who reported that giving Spineless cactus (*Opuntia ficus*) based supplements had non-significantly lowered feed cost per kg of weight gain and higher profit per kg of gain. Similarly, Shrutaliya *et al.*, (2022) reported that, improvement in profit on the replacement of green roughages with Spineless cactus (*Opuntia ficus*) in lambs.

Also, Costa *et al.*, (2013), Nefzaoui *et al.*, (2001), Santos *et al.*, (2017), Ajith *et al.*, (2017), Alhanafi *et al.*, (2019), Thakuria *et al.*, (2020), Sandeepkumr *et al.*, (2022) observed that feeding of cactus was much cost-effective option for animals.

The total feeding cost of treated experimental groups was analyzed and presented in Table. 4.13

**Table 4.13 Cost (Rs) of feed ingredients and Economics of the experimental diets**

Ingredients	Cost /Kg (Rs)	T0		T1		T2	
		Parts (Kg)	Cost (Rs)	Parts (Kg)	Cost (Rs)	Parts (Kg)	Cost (Rs)
Super Napier	1.6	4	6.4	3.2	5.12	2.4	3.84
Spineless cactus	0.1	-	-	0.8	0.8	1.6	1.6
Maize	25	40	1000	40	1000	40	1000
Horse gram	15	30	450	30	450	30	450
Wheat bran	26	27	702	27	702	27	702
Salt	10	1	10	1	10	1	10
Mineral mixture	25	2	50	2	50	2	50
Total		100	2212		2212		2212
Processing Cost (Rs)	5	-	500	-	500	-	500
Total concentrate mix Cost (Rs)	1	-	27.12	-	27.12	-	27.12
Cost of super napier	-	4	6.4	-	5.12	-	3.84
Spineless cactus	-	-	-	0.8	0.8	1.6	1.6
Concentrate mixture (kg)	27.12	0.4	10.84	0.4	10.84	0.4	10.84
Total feed Cost	-	-	17.24	-	16.76	-	16.28
Feeding cost/lamb			879		854		831
Total Cost/Kg Gain			187		184		183

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*Summary &  
Conclusions*

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## CHAPTER V

### SUMMARY AND CONCLUSIONS

The recent research work carried out entitled "Effect of feeding cactus (*Opuntia ficus*) on growth performance of Madgyal lambs" which was conducted at Punyashlok Ahilyadevi Sheep and Goat Development Corporation, Dahiwadi, Dist-Satara. (M.S). In this research work, eighteen (18) healthy Madgyal lambs six (06) in each group with body weights of  $8.91 \pm 0.45$  in T0,  $8.86 \pm 0.93$  in T1 and  $8.81 \pm 0.38$  in T3, respectively of similar age (3-4 months) and of either sex was selected for this trial at the "Madgyal Sheep Unit" of Punyashlok Ahilyadevi Sheep and Goat Development Corporation, Dahiwadi, Dist. - Satara. (M.S) for the period of 90 days. The study was conducted for 90 days to assess the incorporation of Spineless cactus (*Opuntia ficus*) in diets of Madgayl lambs on feed intake, growth performance, haematological and serum biochemical parameter's variations.

Eighteen Madgyal lambs were randomly allotted to three groups and fed with one of the three diets viz., T0 (Control) lambs offered a basal diet containing green roughages and concentrate mixture, T1 lambs offered a basal diet containing 20 per cent Spineless Cactus replaced with green roughages and concentrate mixture while T2 lambs offered a basal diet containing 40 per cent Spineless Cactus replaced with green roughages. The Spineless Cactus (*Opuntia ficus*) had been harvested from ICAR-NIASM, Malegaon, Baramati, Dist:Pune. And transported to Punyashlok Ahilyadevi Sheep and Goat Development Corporation, Dahiwadi, Dist. - Satara. (M.S) for feeding lambs of "Madgyal Sheep Unit". All the lambs were supplemented with concentrate mixture @ 2 percent of the body weight.

The dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE), total ash (TA), neutral detergent fiber (NDF) and acid detergent fiber (ADF) content of spineless cactus were 9.1, 70.6, 5.58, 1.01, 10.89, 53.22, 29.2, 38.6 and 27.25 per cent respectively.

Experimental Madgyal lambs had an initial average body weight of  $17.33 \pm 0.33$ ,  $17.33 \pm 0.31$  and  $17.33 \pm 0.21$  kg respectively in T0, T1 and T2 groups, which grew linearly and attained a body weight of  $27.13 \pm 0.18$ ,  $27 \pm 0.26$  and  $26.73 \pm 0.23$  kg respectively by the end of experiment. Statistical analysis of the data of experiment revealed that there was no significant difference in the fortnightly body weights of the lambs from 1<sup>st</sup> to 6<sup>th</sup> fortnight among three dietary groups. Relatively higher body weight was observed in the control (T0 group) as compare to T1 (20% Spineless Cactus) and T2 (40% Spineless Cactus) group lambs. Among the Spineless Cactus (*Opuntia ficus*) fed lambs, T1 had relatively higher body weight than T2 group, however the differences were non-significant. Overall mean average of body weight was  $22.03 \pm 1.32$ ,  $21.96 \pm 1.3$  and  $21.85 \pm 1.27$  n lambs fed with T0, T1 and T2 experimental diets, respectively. The stastical analysis of data revealed that difference were non-significant.

Madgyal lambs in T0, T1 and T2 group had an average daily gain (g) of  $110.07 \pm 4.04$ ,  $109.01 \pm 4.27$  and  $108.49 \pm 4.36$  g, respectively during 90 days of experimental period and the differences were non-significant. During experiment Control group T0 had higher body weight as compared to treatment groups T1, T2. Among the Spineless Cactus fed lambs, relatively higher ADG was observed in T1(20% Spineless Cactus) when compared to T2 (40% Spineless Cactus).

In this experiment, the haematological parameters was collected and examined in monthly basis for all three experimental groups. It was started with 0 day to 90 day with monthly intervals of 0day, 30<sup>th</sup>, 60<sup>th</sup> and 90<sup>th</sup> days. Haematological prameters includes Hb (Hemoglobin), PCV (Packed Cell Volume), TLC (Total Leukocyte Count), TEC (Total Erythrocyte Count).

Madgyal lambs in T0, T1, T2 groups had mean initial estimated haemoglobin values were  $10 \pm 0.19$ ,  $10.08 \pm 0.48$ ,  $10.05 \pm 0.24$  g/dl respectively while the final hemoglobin values were  $9.93 \pm 0.23$ ,  $9.85 \pm 0.13$ ,  $9.75 \pm 0.22$  g/dl respectively at the end of the 90-day experiment. During the 90 days of experiment non-Significant ( $P < 0.05$ ) differences were observed among T0, T1 and T2 in haemoglobin values among all three experimental groups. While the

control group had higher haemoglobin values than the experimental groups within the normal range.

Madgyal lambs in T0, T1, T2 groups had mean initial estimated PCV values were  $31.83 \pm 0.94$ ,  $31.83 \pm 1.01$ ,  $31.63 \pm 0.98$  % respectively while the final PCV values were  $32.83 \pm 1.24$ ,  $33.16 \pm 0.70$ ,  $31.66 \pm 1.11$  g/dl respectively at the end of the 90-day experiment. The overall mean of PCV (%) values were  $32.66 \pm 0.67$ ,  $32.70 \pm 0.31$  and  $32.19 \pm 0.35$  percent in T0, T1 and T2 groups, respectively. It is observed that, the values of PCV (%) were statistically non-significant in the present study. The different inclusion levels of Spineless Cactus (*Opuntia ficus*) in a ration had a non-significant effect on PCV concentration in the blood.

During the experiment period of 90 days on Madgyal lambs in T0, T1, T2 groups had mean initial estimated TLC values were  $5.06 \pm 0.41$ ,  $5.03 \pm 0.39$ ,  $5.25 \pm 0.51$  ( $\times 10^3/\mu\text{L}$ ) respectively while the final TLC values were  $5.38 \pm 0.52$ ,  $5.41 \pm 0.47$ ,  $5.26 \pm 0.47$  ( $\times 10^3/\mu\text{L}$ ) respectively at the end of the 90-day experiment. The overall mean of TLC ( $\times 10^3/\mu\text{L}$ ) values were  $5.44 \pm 0.18$ ,  $5.49 \pm 0.18$  and  $5.51 \pm 0.15$  ( $\times 10^3/\mu\text{L}$ ) in T0, T1 and T2 groups, respectively. It is indicated that, the values of TLC ( $\times 10^3/\mu\text{L}$ ) were statistically non-significant in the present study and inclusion Spineless Cactus (*Opuntia ficus*) had a non-significant effect on PCV concentration in the blood.

Madgyal lambs in T0, T1, T2 groups had mean initial estimated TEC values were  $11.31 \pm 0.60$ ,  $10.31 \pm 0.65$ ,  $11.08 \pm 0.68$  ( $\times 10^6/\mu\text{L}$ ) respectively while the final TEC values were  $11.93 \pm 0.69$ ,  $11.35 \pm 0.42$ ,  $12.08 \pm 0.85$  ( $\times 10^6/\mu\text{L}$ ) respectively at the end of the 90-day experiment. The overall mean of TEC ( $\times 10^6/\mu\text{L}$ ) values were  $12.06 \pm 0.29$ ,  $11.31 \pm 0.40$  and  $11.83 \pm 0.39$ , ( $\times 10^6/\mu\text{L}$ ) in T0, T1 and T2 groups, respectively. It is observed that, the values of TEC ( $\times 10^6/\mu\text{L}$ ) were statistically non-significant in the present study. So, there was not having any adverse effect of Spineless Cactus (*Opuntia ficus*) on the blood TEC.

At the end of the experiment all the experimental (T0, T1 and T2) group lambs had normal haematological (RBC, WBC, Hb) values in the physiological

range. Similarly, PCV values among three experimental group lambs were comparable.

Biochemical parameters also studied among all three experimental groups which includes Serum glucose, Total Protein, Serum Albumin, SGOT, SGPT.

The serum glucose concentration (mg/dl) before the start of experiment in growing Madgyal lambs in different experimental groups T0, T1 and T2 was  $55.16 \pm 1.62$ ,  $54.83 \pm 1.42$  and  $56.83 \pm 1.40$  fed with or without Spineless Cactus (*Opuntia ficus*) While at the end of the experiment, serum glucose concentration (mg/dl) of  $68.66 \pm 1.14$ ,  $65.58 \pm 3.59$  and  $67.29 \pm 3.50$  were observed in T0, T1 and T2 groups, respectively (Table 4.8 and Graph 4.7). The results revealed that, the supplementation of Spineless Cactus (*Opuntia ficus*) in the diet showed no significant difference among three experimental group lambs. Concentration of serum glucose (mg/dl) was relatively higher in T1 and T2 as compared with T0 group lambs.

The mean values of Total protein concentration (g/dl) in T0, T1 and T2 experimental Madgyal lamb groups before the start of the experiment were  $6.5 \pm 0.18$ ,  $6.58 \pm 0.24$  and  $6.73 \pm 0.21$  thereof at the end of the experiment were  $6.95 \pm 0.08$ ,  $6.67 \pm 0.20$  and  $6.60 \pm 0.15$ , respectively (Table 4.9 and Graph 4.8). Total protein concentration (g/dl) was non-significant ( $P < 0.05$ ) among three different experimental group lambs. The results observed that, the supplementation of Spineless Cactus (*Opuntia ficus*) in the diet showed no significant difference among three experimental group lambs

In Madgyal lambs of different experimental groups T0, T1 and T2, before start of the experiment had a mean serum albumin concentration (g/dl) of  $2.50 \pm 0.11$ ,  $2.53 \pm 0.16$  and  $2.65 \pm 0.11$  while at the end of the experiment were  $2.55 \pm 0.08$ ,  $2.65 \pm 0.18$  and  $2.91 \pm 0.19$ , respectively. Statistical analysis of the data at the end of the experiment revealed a non-significant difference for serum albumin among three experimental groups. The mean serum albumin levels of Madgyal lambs were relatively higher in T1 and T2 groups than control group lambs, however the values are within the normal physiological range.

The average values of SGOT enzyme at start of experiment for the T0, T1 and T2 groups were found to be  $141.76 \pm 5.19$ ,  $142.20 \pm 11.68$  and  $143.11 \pm 11.80$  IU/L, respectively while at 90 days of experiment it was found to be  $142.66 \pm 9.9$  IU/L for T0 group,  $145.46 \pm 11.48$  IU/L for T1 group and  $143.98 \pm 9.64$  IU/L for T2 group. The overall mean values of SGOT enzyme for the T0, T1 and T2 groups were calculated to be  $141.86 \pm 0.31$ ,  $141.48 \pm 1.53$  and  $143.33 \pm 0.45$  IU/L, respectively which differed non-significantly from each other (Table 4.11). The results revealed that, the supplementation of Spineless Cactus (*Opuntia ficus*) in the diet showed no significant difference in serum enzyme SGOT levels when the lambs fed with experimental diets.

The mean values of SGPT among all experimental groups were  $28.21 \pm 1.33$ ,  $27.64 \pm 2.52$  and  $27.73 \pm 0.44$  While at the end of experiment it was found to be  $29.71 \pm 1.27$  IU/L for T0 group,  $28.90 \pm 0.48$  IU/L for T1 group and  $29.63 \pm 1.28$  IU/L for T2 group. The overall mean values of SGPT enzyme for the T0, T1 and T2 groups were calculated to be  $30.08 \pm 0.74$ ,  $29.25 \pm 0.62$  and  $29.40 \pm 0.57$  IU/L, respectively which differed non-significantly from each other (Table 4.12). The results revealed that, the supplementation of Spineless Cactus (*Opuntia ficus*) in the diet had no significant difference was observed for serum enzyme SGPT levels among the three experimental group lambs.

Statistically non-significant differences were observed in the mean serum glucose (mg/dl), serum albumin (g/dl) and serum total proteins (g/dl) values in lambs among three groups (T0, T1 and T2) both before start of the experiment and at the end of the experiment. However, significantly higher ( $P < 0.05$ ) serum glucose (mg/dl), serum total proteins (g/dl) were observed in T1 and T2 group lambs fed with cactus compared to the control lambs fed without cactus. However, liver function tests (SGOT, SGPT) had normal values before the start of the experiment and after the end of the experiment. This indicates that the Cactus doesn't content any toxic substance which can harm liver.

Total cost of feed in T0, T1 and T2 group experimental lambs was Rs17.24, Rs. 16.76 and Rs. 16.28. It shows that the total feed cost was low in T2 group. Whereas, the cost of feed per Kg body weight gain in Madgyal lambs fed

with experimental diets was Rs. 187, 184 and 183 for T0, T1 and T2 groups respectively. There was no significant difference between three groups in cost of production. There was no significant difference between three groups in cost of production. Hence the feeding of Spineless Cactus has no effect on cost of production. However, feeding Spineless Cactus is more economical than normal feeding of fodder.

### **CONCLUSION:**

The present study indicated that Spineless cactus could be a source of energy for inclusion in the diet of lambs. Inclusion of Spineless cactus in the diets significantly decreases the voluntary intake of water (per unit feed DM intake), thus spineless cactus could also be a good source of water to meet the demands of the body. Spineless Cactus is also a good source of minerals like calcium, iron and manganese. Considering the overall performance of the animals in terms of feed intake, average daily gain, it was concluded that Spineless cactus could be a good unconventional, valuable fodder resource especially in rainfed drylands and could replace other feed stuffs like Super napier in all the season where super napier shows dormancy in the winter season.

The parameters studied were proximate analysis of feed, growth performance, feed intake on basis of dry matter intake, haematological parameters such as Hb, PCV, TEC count and TLC count, Hematobiochemical parameters such as SGOT, SGPT, Serum glucose, Serum albumin, Total Protein and feeding economics of experimental Madgyal lambs.

The experimental Madgyal lambs were fed dry roughages and greens in addition to the @ 2 percent of concentrate mixture under intensive farming system. The feeding regimens of the experimental growing lambs in the control and treatment groups were similar, with the replacement of green roughages with Spineless Cactus (*Opuntia ficus*). The trial was conducted for 90 days of period. T0 (Control group) stall feeding with dry and green fodder + concentration mixture as per usual feeding practice (ICAR, 2013), T1 (Treatment group) stall feeding with dry and green fodder + concentrate mixture + 20% of green roughages replaced with chopped Spineless cactus while in T2 (Treatment group)

stall feeding with dry and green fodder + concentrate mixture + 40% of green roughages replaced with chopped Spineless cactus.

The data generated throughout the study was statistically analyzed to evaluate the findings. A chopped Spineless cactus was prepared for feeding of lambs during this present research work. Spineless Cactus was analyzed for proximate analysis to determine DM, CP, EE, CF, NFE and total ash by the AOAC, (2000) guidelines. Feed was offered on an initial weight basis to experimental lambs. The record of body weights was noted at every fortnight intervals. From the fortnightly body weight gain records, the daily body weight gain was calculated. The daily feed intake was recorded from feed offered and feed leftovers. The blood samples were collected from each animal every monthly interval for analysis of hematological parameters such as Hb, PCV, TEC and TLC, also for hematobiochemical parameters SGOT, SGPT, Serum glucose, Serum albumin, Total Protein and at the end of the work the feed economics was calculated by cost of feed intake/kg weight gain.

During the chemical analysis of feed, it is reported that, DM, CP, EE, CF, NFE, TA, and content Spineless Cactus (*Opuntia ficus*) was 9.1, 5.58, 1.01, 10.89, 53.22 and 29.2 respectively. The growth performance was recorded on fortnightly body weight gain and daily body weight gain. In the final fortnight body weights (Kg) were recorded as  $22.03 \pm 1.32$ ,  $21.96 \pm 1.3$  and  $21.85 \pm 1.27$  and the mean fortnightly body weights (Kg/fortnight) were  $22.03 \pm 1.32$  kg,  $21.96 \pm 1.3$  kg and  $21.85 \pm 1.27$  in T0, T1 and T2 groups, respectively. The fortnightly and average body weight gain were found to be non-significant in the present study. The average daily gain (gm/head/day) in T0, T1 and T2 groups were  $110.07 \pm 4.04$ ,  $109.01 \pm 4.27$  and  $108.49 \pm 4.36$ , respectively. It was observed that, the average daily gain were higher in the control group than in the treatment groups however, it was statistically non-significant. It can be concluded that, there was no adverse effect of feeding chopped Spineless cactus (*Opuntia ficus*) in replacement of green roughages to experimental lambs with a gain in body weight.

Blood samples were taken at 0, 30, 60 and 90<sup>th</sup> days from each experimental animal and used for further analysis. In all three groups, the hemoglobin (gm/dl) values remained within the normal physiological range

throughout the experimental period. The overall mean hemoglobin values of T0, T1 and T2 groups were observed to be  $9.98 \pm 0.08$ ,  $9.95 \pm 0.05$ ,  $9.82 \pm 0.08$  (gm/dl), respectively which indicate that, Hemoglobin levels were little higher in the T0 group, but this difference was not statistically significant. It can be concluded that, there was not any adverse effect of chopped Spineless cactus (*Opuntia ficus*) in replacement of green roughages to experimental on Hb values. The overall mean PCV (%) values of the T0, T1 and T2 groups were observed to be  $32.66 \pm 0.67$ ,  $32.70 \pm 0.31$  and  $32.19 \pm 0.35$  percent, respectively. The values of PCV were found to be in the normal physiological range in sheep. The mean average values of PCV (%) were found non-significant and no adverse effect on the PCV values of experimental lambs due to inclusion of chopped Spineless cactus in their ration.

The overall mean of total leukocyte count (TLC) values of T0, T1 and T2 groups were observed to be  $5.44 \pm 0.18$ ,  $5.49 \pm 0.18$  and  $5.51 \pm 0.15$  ( $\times 10^3/\mu\text{L}$ ) respectively and these values were in normal physiological range and statistically found non-significant. It denotes that, the experimental animals were healthy and disease free in all treatment groups. The overall mean of total erythrocyte count (TEC) values of T0, T1 and T2 groups was observed to be  $12.06 \pm 0.29$ ,  $11.31 \pm 0.40$  and  $11.83 \pm 0.39$ , ( $\times 10^6/\mu\text{L}$ ) respectively. The values of TEC are in the normal physiological range and statistically non-significant.

For hematobiochemical parameters, the blood samples were collected at monthly intervals from each Madgyal lambs and serum was extracted and analyzed for Serum Glucose, Total Protein, Serum Albumin, Serum Glutamic Oxaloacetic Transaminase, Serum Glutamic Pyruvic Transaminase. Serum Glutamic Oxaloacetic Transaminase (SGOT) values were within the normal physiological range. The overall mean SGOT values of T0, T1 and T2 groups were observed to be  $141.86 \pm 0.31$ ,  $141.48 \pm 1.53$  and  $143.33 \pm 0.45$  IU/L, respectively. which indicates that, values of SGOT are in normal range in all experimental groups but, it was non-significant. Serum Glutamic Pyruvic Transaminase (SGPT) values were in normal physiological range. The overall mean SGPT values of T0, T1 and T2 groups were observed to be  $30.08 \pm 0.74$ ,  $29.25 \pm 0.62$  and  $29.40 \pm 0.57$  IU/L, respectively. Which indicates that, values of SGPT in the Spineless cactus (*Opuntia ficus*) feeding groups and control group

were statistically non-significant.

While calculating feed economics, the total feed cost (₹) per lamb in T0, T1 and T2 groups were Rs17.24, Rs. 16.76 and Rs. 16.28, respectively. It indicates that, the feeding cost per lamb was lower in the T2 group than in T1 and further T1 group are lower than in the T0 group. The feeding cost per kg weight gain was Rs. 187, 184 and 183 for T0, T1 and T2 groups, respectively. The feeding cost per Kg weight gain was lower in the T2 group than T1 group and further T1 group are lower than the T0 group. From the present study, it can be concluded that, feeding Spineless cactus (*Opuntia ficus*) in the diet of Madgyal lambs is economical for the farmers as it lowers the feeding cost per animal. The present study indicates that, replacing Spineless cactus (*Opuntia ficus*) for green roughages at 20% and 40% levels are economical for farmers as it lowers the feeding cost per animal.

#### **Conclusions-**

1. Replacement of Spineless Cactus (*Opuntia ficus*) for green roughages up to 20% and 40% had a non-significant effect on the fortnightly body weights of experimental animals (Madgyal lambs).
2. There was a non-significant effect on average daily body weight gain in experimental animals (Madgyal lambs) fed on chopped Spineless Cactus (*Opuntia ficus*).
3. Replacement of Spineless Cactus (*Opuntia ficus*) for green roughages up to 20% and 40% in sheep can sustain the ADG.
4. There was non-significant effect on Hb, PCV, TEC and TLC in experimental animals (Madgyal lambs) fed on chopped Spineless Cactus (*Opuntia ficus*).
5. Replacement of Spineless Cactus (*Opuntia ficus*) for green roughages up to 20% and 40% of experimental animals (Madgyal lambs) had non-significant effect on Serum Glutamic Oxaloacetic Transaminase (SGOT), Serum Glutamic Pyruvic Transaminase (SGPT).
6. There was a non-significant increase in Serum glucose and Total Protein values in treatment groups as compared to control group in experimental

animals (Madgyal lambs).

7. There was non-significant effect of inclusion Spineless Cactus (*Opuntia ficus*) for green roughages up to 20% and 40% on Serum albumin levels though values remain in normal physiological range in experimental animals (Madgyal lambs).
8. It was found that, the replacement of Spineless Cactus (*Opuntia ficus*) for green roughages up to 20% (T1 group) and 40% (T2 group) of experimental animals (Madgyal lambs) was economical, when compared to the control group (T0).
9. The present study indicates that, replacing Spineless Cactus (*Opuntia ficus*) for green roughages up to 20% (T1 group) and 40% (T2 group) for experimental animals (Madgyal lambs) non-significant increase in serum glucose and Total protein

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# *Vita*

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## VITA

The author Dr. Pawar Akshaykumar Ashokrao was born on 25<sup>th</sup> July 1997 at Vhantal, Tal. Omerga, Dist. Dharashiv of Maharashtra state. He completed his school examination in 2012 from Saraswati Vidyalaya, Latur with first division. He went on to complete his Higher secondary examination in the year 2014 from Dayanand Science College, Latur.

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# *Abstract*

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### THESIS ABSTRACT

- 1) Title of the thesis : **EFFECT OF FEEDING SPINELESS CACTUS  
(*Opuntia ficus*) ON GROWTH  
PERFORMANCE OF MADGYAL LAMBS**
- 2) Full name of student : Mr. Pawar Akshaykumar Ashokrao
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- 5) Year of award of degree : 2024
- 6) Major subject : Livestock Production and Management
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- 8) Number of words in the abstract : 186
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### ABSTRACT

The present work was conducted on eighteen Madgyal lambs divided in three groups with 6 lambs in each for 90 days to assess the “Effect of feeding spineless cactus (*opuntia ficus*) on growth performance of Madgyal lambs”. The

feeding schedule was stall feeding with a dry and concentrated mixture + chopped spineless cactus replaced for green roughages with 20% in T1 and 40% in T2. Average fortnightly weight gain and ADG values of T0, T1 & T2 were 22.03, 21.96, 21.85(kg) & 110,109,108 gm/head/day, respectively. Nonsignificant values were observed in all weeks of fortnight and ADG. The average values of Haemoglobin, PCV, TLC, and TEC, were recorded as 9.98,9.95,9.82gm/dl,32.66,32.70,32.19 (%), 5.44,5.49,5.51, 12.06,11.31,11.83,` The average values of serum glucose, Total protein, Serum albumin, SGOT and SGPT were recorded as All the values of haemato-biochemical parameters were found to be non-significant in all groups. Feeding cost/kg weight gain was recorded as 187,184,183 in the T<sub>0</sub>, T<sub>1</sub>, and T<sub>2</sub> groups respectively. The study indicates that the chopped spineless cactus will be economical for raising lambs and have no adverse effect on experimental animals.

### प्रबंध सारांश

- १) प्रबंधाचे शीर्षक : निवडुंगाच्या (बिनकाटेरी) खाद्यात वापर करून माडग्याल कोकरांच्या वाढीवर होणारा परिणामाचा अभ्यास करण्यासाठी सदर प्रयोग करण्यात आला.
- २) विद्यार्थ्यांचे पूर्ण नाव : पवार अक्षयकुमार अशोकराव
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- ६) विषय : पशुउत्पादन आणि व्यवस्थापन
- ७) प्रबंधातील एकूण पाने : ६८
- ८) गोषवारा मधील एकूण शब्द : २१४
- ९) विद्यार्थ्यांची स्वाक्षरी :
- १०) सादर कर्ता :  
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### गोषवारा

सध्याचे काम अठरा माडग्याल कोकरांना तीन गटामध्ये विभाजून ९० दिवसासाठी प्रत्येकी ६ कोकरे यांच्यावर “निवडुंगाच्या (बिनकाटेरी) खाद्यात वापर करून माडग्याल कोकरांच्या वाढीवर होणारा परिणाम” याचे मूल्यांकन करण्यासाठी सदर प्रयोग करण्यात आला होता. फीडिंग शेड्यूल स्टॉल फीडिंग होते. हिरवा चारा + एकाग्र मिश्रण (T० नियंत्रण

), २० % हिरवा चारा निवडुंगाने बदलले (T१) आणि ४० % हिरवा चारा निवडुंगाने बदलले (T२). T०, T१, T२ गटांची सरासरी पाक्षिक वजन वाढ आणि दिवसाला होणारी वजन वाढ अनुक्रमे २२.०३, २१.९६, २१.८५ (किलो) आणि ११०, १०९, १०८ (ग्रॅम/डोके /दिवस ) होती. पंधरवाड्यातील सर्व आठवडे आणि दिवसाला होणारी वजन मध्ये गैर महत्वपूर्ण मूल्ये पहिली गेली. हिमोग्लोबिन, पिसीव्ही, टीएलसी, टीईसी ची सरासरी मूल्ये ९.९८, ९.९५, ९.८२ (ग्रॅम/डीएल) ३२.६६, ३२.७०, ३२.१९ (%), ५.४४, ५.४९, ५.५१ (x १०<sup>३</sup>ul) १२.०६, ११.३१, ११.८३ (x १०<sup>६</sup> ul). T०, T१, T२ गटामध्ये अनुक्रमे नोंदीवली गेली. तसेच सिरम ग्लुकोज , टोटल प्रोटीन , सिरम अलबूमिन, एसजिओटी, एसजिपिटी सरासरी मूल्ये ६५.२१, ६५.५८, ६७.२९ (मिलिग्रॅम/डीएल), ६.७०, ६.६६, ६.७० (ग्रॅम/डीएल), २.६०, २.६२, २.७३ (ग्रॅम/डीएल), १४१.८६, १४१.४८, १४३.३३ (आययू/लिटर), ३०.८, २९.२५, २९.४० (आययू/लिटर), T०, T१, T२ गटामध्ये अनुक्रमे नोंदवली गेली. हिमयआटो बायो केमिकल पॅरामिटर्स सर्व मूल्ये सर्व गटामध्ये गैर महत्वपूर्ण आढळली.

T०, T१, T२ गटामध्ये आहार खर्च/किलो वजन वाढणे अनुक्रमे १८७, १८४, १८३ नोंदविले आहे

अभ्यास दर्शवतो की निवडुंग चारण्याचा खर्च आर्थिक रीतीने बदलला जाऊ शकतो . जो कोकरू वाढविण्यासाठी किफायतशीर असेल आणि प्रायोगिक प्राण्यावर कोणताही प्रतिकूल परिणाम होणार नाही.