



**An-Najah National University**  
**Faculty of Graduate Studies**

**EFFECTS OF DIFFERENT FORMS OF DATE  
PALM (*ELAEIS QUINEENSIS JACQ.*) LEAVES  
ON THE PERFORMANCE AND SOME  
PRODUCTIVE AND REPRODUCTIVE  
TRAITS OF CROSSBRED EWES**

**By**

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**This Thesis is Submitted in Partial Fulfillment of the Requirements for the Degree of  
Master of Animal Production, Faculty of Graduate Studies, An-Najah National  
University, Nablus - Palestine.**

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## **Dedication**

I dedicate this humble work to God Almighty first, for the innumerable goodness and blessings He bestowed upon us, and to the pure soul of my father who taught us sincerity and dedication to work, and to my mother, the crown of the head and the apple of my eye, and to my dear wife, my second half, and to my beloved sons and daughters, and to my dear colleagues, and to my distinguished professors... for the support they gave me to continue the path of knowledge in these difficult circumstances, as each of them had a great impact on the completion of this work.

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## Declaration

I, the undersigned, declared that I submitted the thesis entitled:

**EFFECTS OF DIFFERENT FORMS OF DATE PALM (*ELAEIS QUINEENSIS JACQ.*) LEAVES ON THE PERFORMANCE AND SOME PRODUCTIVE AND REPRODUCTIVE TRAITS OF CROSSBRED EWES**

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

**Student's Name:** Ali Abdo Ali Shakhshir

**Signature:**



**Date:** 27/02/2025

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**EFFECTS OF DIFFERENT FORMS OF DATE PALM (*ELAEIS QUINEENSIS JACQ.*) LEAVES ON THE PERFORMANCE AND SOME PRODUCTIVE AND REPRODUCTIVE TRAITS OF CROSSBRED EWES**

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**Abstract**

This research comprised two experiments. The first experiment aimed to examine how various preparations of date palm leaves (DPL), including chopped, ensiled, and alkali-treated forms, affected the performance and reproductive efficiency of crossbred ewe lambs. A total of twenty female ewes were used at age of 6-7 months were fed the DPL at 15% of their diets for a period of 6 weeks. DPL replaced a similar percentage of wheat hay in the control diet. The ewes were split into four experimental groups, with each group consisting of five ewes, and each ewe treated as a separate replicate. Ewes were fed as the following: Group 1 (G1) served as the control, consisting of 70% concentrate and 30% wheat straw, for the experimental groups G2 to G4, various forms of date palm leaves (DPL) were incorporated into the diets to replace half of the wheat straw. A digestion trial was conducted after 28 days of the feeding trial. Ewes were exposed to rams were conception rates and other reproductive traits were recorded. Prior to conception ewes were examined for blood parameters and a digestibility trial was performed. The results indicated that the form of DPL had no significant effects on all study parameters. The second experiment consisting of 28 cross-bred lactating ewes were used to examine the DPL forms on milk yield and quality, blood parameters and nutrient digestibility. The ewes were organized into four experimental groups, with each group containing seven ewes, and each ewe regarded as an individual replicate. Ewes were fed with similar diets as in experiment 1. Results of experiment 2 indicated the lack of effects of forms of DPL on the tested parameters. In experiments 1 and 2 the economic efficiency of feeding DPL was examined. In conclusion, incorporating date palm leaves (DPL), whether in their raw or treated forms (ensiled or alkali-treated), offers significant benefits by lowering feed

costs and contributing to environmental protection. However, further research is needed to determine the optimal treatment and inclusion levels for these diets.

**Keywords:** Date Palm Leaves; Crossbreed Sheep; Fodder.

# **Chapter One**

## **Introduction**

The livestock sector is a vital sector as it contributes to fulfilling the world food security needs by providing essential commodities such as milk and meat. Similarly, this sector is the backbone in Palestinian food security. Numbers of livestock are increasing during the last two decades as indicated (PCBS, 2021). Recently, small ruminant breeders have shown reluctance to continue in raising sheep and goat and that because of huge feeding costs, which constitute over seventy percent of expenses (Abo Omar et al., 2021). The elevated expenses associated with feed represent a significant challenge for livestock industries globally, including in Palestine. Consequently, many sheep farmers have discontinued their farming operations due to this issue. Moreover, reduced milk yield per unit intensifies the effect of high feed costs, highlighting the need for farmers to enhance their profitability.

The use of by-products from agricultural farming and food processing industries as feed for livestock has been a traditional practice for many years, originating with the domestication of animals. This approach provides two key benefits (Grasser et al., 1995). It lessens livestock reliance on grains meant for human consumption and reduces the necessity for expensive waste management schemes. The latter aspect has become increasingly critical over the past few years due to the growth in the global human population, along with the supply of agriculture and food processing by-products, especially in low-income countries.

Reducing high feed costs and enhancing animal production are critical objectives (Devendra & Leng, 2011). One promising approach is the adoption of unconventional feeding systems, such as incorporating silage derived from by-products like palm trees and almonds into animal diets (Mahmood et al., 2023). Numerous case studies in the West Bank have explored the impact of using silage in sheep rations on milk production and fattening (Zaazaa et al., 2022). Yet, there is a notable lack of consistent information to evaluate the impact of silage on these parameters. In order to help farmers, move forward with using by-products and spread valuable information throughout the West Bank (WB), this research project aims to collect fattening data from the use of by-products prepared

specifically for this purpose. Moreover, a feasibility study was carried out to determine the financial profit of using by-products in small ruminant feed.

Many studies have addressed the issue of escalating costs associated with agricultural inputs, particularly focusing on livestock feeds (Devendra & Leng, 2011). Nevertheless, there is a notable scarcity of research aimed at identifying solutions to this challenge. It is essential to investigate the accessibility and nutritional significance of local agriculture and industrial by-products, as suggested in this study.

Furthermore, there is a notable absence of recorded data concerning the reproductive performance of crossbred sheep under semi-intensive management practices in Palestine.

The study by (Atta et al., 2024) investigated the impact of incorporating Date Palm Leaf (DPL) into the diets of Awassi ewes raised in arid environments. The experiment used a randomized block design with two total mixed rations (TMR) based on Rhodes grass and barley, supplemented with discarded dates and crushed fronds. Key metrics included the service date, weights at conception and lambing, and lamb weights at birth and weaning (90 days). Results showed that the diet had no significant effect on conception and lambing rates ( $P > 0.05$ ), gestation lengths, lambing intervals, litter sizes, or weights of lambs at birth and weaning, nor on the annual weight of weaned lambs per ewe.

A significant challenge confronting the animal production sector in semi-arid and arid regions is the scarcity of available feed resources. Research indicates that feed costs account for approximately (75%) of expenditures in livestock projects (Abo Omar & Omar, 2012). Consequently, it is advisable to investigate alternative feed sources, such as agricultural byproducts, and enhance the nutrition value of existing feeds. This may be achieved through chemical, mechanical and biological treatments of low-value feed ingredients (Morsy et al., 2021, 2020; Abo Omar & Omar, 2012).

Among these, (DPL) represents a significant crop residue in West Bank and various other arid regions. In Palestine, there are around three million palm trees, yielding more than fifteen thousand tons of leaves annually (PCBS, 2021). Despite that, are often underutilized because of their fiber content is high, ranging from (43%) to (73%) neutral detergent fiber (Kholif et al., 2022), and low crude protein levels, which are between (4.2%) and (16.5%) of dry matter (Kholif et al., 2022; Medjekal et al., 2011). This also,

contributes to their poor nutritive value and digestibility (Gouda et al., 2022; Kholif et al., 2022).

Ensiling and silage additives are commonly used to improve the quality and digestibility of poor-quality forages. This process mainly aimed to enhance the fermentation and overall nutrients quality of the forages while also minimizing harmful bacterial growth rates and mitigating the adverse impact of certain anti-nutritional factors present in animal feeds (Gouda et al., 2022; Kholif et al., 2022).

However, ensiling is often ineffective for certain feed ingredients and byproducts, such as Date Palm byproduct, due to their robust physical structure and the low content of water-soluble sugars. These factors hinder the ability to produce quality silage through natural fermentation. To Figure out this issue, alternative treatments such as alkali treatment have been suggested as potential solutions (Shtayeh, 2022). Therefore, the objective of the this research project was to assess the inclusion different forms of (chopped, ensiled, alkali treated DPL) in the diet of ewe lambs and lactating crossbred ewes on animals performance, reproductive efficiency, feeding intake, the digestion process, the production of milk, composition of milk , and the economic efficiency in arid and semi-arid conditions of Palestine. Our findings are anticipated to yield valuable insights regarding which raw waste can be integrated into livestock diets and the potential cost savings that may result.

Locally, there is a notable interval between what is produced and what is consumed of feed or fodder crops (see details in the study section on feed production). Therefore, it is important to study the problems and obstacles facing feed and fodder crops and find the necessary solutions to support pastoral expansion, increase agricultural areas, and boost productivity.

## **1.1 Literature review**

Palestine is strategically positioned in the Eastern Mediterranean, bordered by the Mediterranean Sea to the west and neighboring countries to the east. Its geographic coordinates range from 29° to 33° north latitude and 35° to 39° east longitude, covering an area of approximately 6,245 square kilometers that includes the West Bank (WB) and the Gaza Strip (GS).

The region is characterized by a diverse Mediterranean climate, with distinct seasonal variations that influence agricultural practices. Winters are generally rainy, while summers tend to be hot and dry. Precipitation levels vary across the landscape, with the northwest reaching up to 700 mm annually, in contrast to the southeastern areas that may receive only around 150 mm.

Palestine's agricultural landscape is segmented into four primary agro-ecological zones: the semi-coastal area, the central highlands, the eastern slopes, and the Jordan Valley. Each zone offers unique environmental conditions that support a variety of crops and farming practices, reflecting the region's rich agricultural heritage and its adaptation to climatic and geographical differences.

The latest statistics indicate that cultivated or arable land comprised approximately forty-two percent of the total land area, whereas open land regardless of its vegetation levels accounted for about twenty-nine percent of Palestinian territory (PCBS, 2021). Furthermore, pastures made up only about twelve percent of the arable land in Palestine (PCBS, 2021).

## **1.2 Overview of the Palestinian Agricultural Sector**

The area of WB and GS is about 6.023 million Donums (1 Donum = 1000 m<sup>2</sup>), with (94%) situated in the West Bank.

According to the 2021 agricultural census, around 1.2 million Donums, or (21%) of the total area, are utilized for agricultural purposes, with (90%) of this land located in the WB and the remaining (10%) in GS. Within this agricultural area, 217,206 Donums are dedicated to field crops, representing (19.8%) of the total cultivated land (PCBS, 2021). Despite the critical role agriculture plays in the Palestinian economy, it has faced significant challenges, including restrictions on access to agricultural resources in Area

(C), which is under full Israeli control and comprises (61%) of Palestinian agricultural land (PCBS, 2021).

There is a total of 140,000 agricultural holdings in Palestine. Of these, 106,653 are held by female owners, while 127,332 are managed by male owners (PCBS, 2021).

In 2021, the agricultural sector employed approximately 59,600 workers, with about 44,000 located in the West Bank and 15,600 in Gaza. The average daily wage for these workers was 54.8 shekels, with a notable disparity between the regions: workers in the West Bank earned an average of 89.5 shekels per day, while those in Gaza received only 20.9 shekels (PCBS, 2021).

Despite its significance, the agricultural sector has experienced a marked decline, with its contribution to the Gross Domestic Product (GDP) plummeting from (36%) in the 1970s to just (3%) by 2017. In 2021, the added value of the agricultural sector reached approximately 977.5 million U.S. dollars, with Gaza accounting for 260.4 million dollars and the West Bank contributing 717.1 million dollars (PCBS, 2021).

There was a noticeable increase in the GDP from 1994 to 1999. However, in 2000, which marked the outbreak of the Intifada, most economic activities were halted due to repeated closures and security conditions, and this situation continued until 2003. After that, the Palestinian economy witnessed a relative recovery due to the relative calm in political and security conditions, especially after the period of the Al-Aqsa Intifada, which reached its peak until around 2004 (PCBS, 2021).

The Palestinian economy recovered after that period until 2019. However, due to the economic recession and forced closures that Palestine suffered from, the economy slowed down during 2020 and 2021, mainly due to the COVID-19 pandemic that swept the world. This led to a decline in local economic growth indicators and a 5.7% decrease in GDP, although recovery began in 2021 as lockdown measures were eased and economic activity gradually resumed (PCBS, 2021).

The WB and GS have a total pasture area of about 2.02 million Donums. However, the usable area is restricted to around 621,000 Donums, largely because of Israeli settlements, military zones, and the separation wall. This leads to increased grazing pressure and

overgrazing practices, especially as they suffer from low annual rainfall rates, ranging between 100 and 250 mm annually (PCBS, 2021).

### **1.3 Difference between Feed and Forage**

This study primarily focused on the production chain of fodder crops and the key differences between fodder crops and feed can be summarized as follows:

– **Concept:**

- A. Concentrate feed is a mixture of various raw ingredients, it is often presented in forms like mash, crumbling, or pellets.
- B. Forage crops natural feed provided to animals such as straw, silage, and pasture plants, are natural.

– **Components:**

- A. Concentrate feed consists of (wheat, barley, corn, soy, etc.) and nutritional additives that are formulated according to the livestock's needs.
- B. Forage crops mainly consist of fresh plants or parts of them and may include silage.

– **Manufacturing:**

- A. Concentrate feed undergoes significant manufacturing processes to enhance digestibility and nutritional value.
- B. Forage crops minimal processing, and it's often consumed in its natural form.

– **Nutritional Value:**

- A. Concentrate feed is manufactured to be nutritionally complete.
- B. Forage crops may require supplements to achieve a balanced diet.

– **Usage:**

- A. Concentrate feed is used in intensive livestock systems.
- B. Forage crops are commonly used in traditional farming systems. They also serve as fillers in intensive farming to regulate milk fat and support digestion.

## **1.4 Nonconventional Fodder Crops**

These are plants specifically cultivated to be used as livestock feed. Examples of such crops include Guar, Panicum, Azolla, and Algae. Fodder crops are characterized by their high dry matter yield, ability to withstand climatic changes, and contribution to agricultural diversity.

Fodder crops in livestock ration are classified as bulk feed and have possibilities to grow in different climates, with varied nutritional values based on their content of crude protein (CP). Furthermore, these crops are characterized by their high productivity and the ability to be irrigated with treated water. Researchers assessed the nutritional feasibility of using Guar as a feed for small ruminants in Palestine and they found a positive potential (Abo Omar et al., 2021). Moreover, researchers in countries within the region found that crops like Azolla, Panicum, and Algae have verified their efficacy as feed for livestock. These unconventional fodder crops have strengths points like high dry matter content along with good nutritional quality and high adaptive capacity to change in climate. Although there are challenges that can be considered as weaknesses points and it include: the lack of technology and knowledge to cultivate these crops, farmers are reluctant to introduce them in feed rations because of its modernity, and the logistical arrangements requires.

## **1.5 Feed Consumption in West Bank**

In 2020, the northern governorates of the West Bank consumed approximately 800,000 tons of feed, about (70%) of which was imported. Feeding is one of the most significant costs in animal production, representing (75-85%) of the overall cost of milk production and (55-65%) of the total cost of small ruminants ( Abo Omar & Omar, 2012; Abo Omar et al., 2021) . More than (95%) of energy feeds (wheat, barley, corn...etc.) and (85%) of protein feed (soybean meal) are imported from Israel. Most of the concentrated and fodders are imported from Israel for use in livestock rations. The increasing feed cost has led small farmers to choose to use cheaper and lower-quality alternatives. However, concentrated feed is produced by 33 factories in the West Bank, most of which are in the northern region (PCBS, 2021).

## 1.6 Livestock in Palestine

Statistical data has shown an increase in livestock numbers over the past decade (Table 1), particularly in the West Bank, indicating a growing Palestinian demand for feed and fodder crops. This necessitates attention from relevant authorities, especially the Ministry of Agriculture, to support this sector and enhance the quantity and quality of the local production of feed. The following table illustrates the increase in livestock numbers in WB and GS:

**Table 1**

*Development of livestock population in Palestine*

Indicator	2010			2021		
	WB	GS	Palestine	WB	GS	Palestine
Number of Animal Holdings	10,879	3,362	14,241	12,278	7,631	19,909
Number of Cows	24,290	9,635	33,925	53,182	14,578	67,760
Number of Sheep	505,833	61,403	567,236	713,271	57,897	771,168
Number of Goats	207,214	12,150	219,364	231,328	8,638	239,966
Number of Camels	746	775	1,521	998	549	1,547
Number of Broiler Chickens	23,554,904	7,556,507	31,111,411	57,075,585	13,943,437	71,019,022
Number of Layer Chickens	1,233,736	311,280	1,545,016	3,081,127	565,358	3,646,485
Number of Bee Colonies	29,040	9,176	38,216	47,595	16,765	64,360
Number of Turkeys	486,460	34,670	521,130	290,900	237,390	528,290

Source: Draft for Review by the Planning and Budgeting Group, 30/10/2023.

{WB: West bank, GS: Gaza strip}

The livestock industry faces many obstacles, not the least of which fears feed resources. It is well established that feed expenses constitute over (70%) of production costs (Abo Omar & Omar, 2012). To solve this situation, efforts have been made to incorporate unconventional feed ingredients for sheep farming. These alternatives can effectively utilize significant amounts of agricultural and industrial waste, thereby reducing reliance on concentrate feeds ( Shtayeh, 2022, Abo Omar & Omar; 2012).

### **1.7 Date Palm Leaves (DPL) as fodder**

High feed costs are one of the biggest obstacles to livestock production globally and in Palestine. Many sheep farmers have sold their livestock due to rising feed costs. In addition, milk unit production is low, and feed costs are high, resulting in reduced farmers' income and affecting farmers' profitability. Livestock holds significant economic importance in many developing nations and is essential for ensuring food security among their rural communities.

Among the agricultural wastes that can be fed to ruminants is the date palm leaves. Significant amount of this raw material is available in areas cultivated with palm trees, mainly the Jordan valley. Traditionally, DPL is fed to ruminants after being chopped without any further treatment. However, the DPL treated was incorporated in ruminant rations with a promising outcome regarding animals' performance and profitability.

All five continents of the world are suitable for date palm cultivation, with much of the plant growing between latitudes 39° north and 20° south. Nonetheless, (89%) of dates are produced in the Middle East and North Africa, making this the primary production region. Previous studies have mentioned that date palm leaves can be added to animal feed (Elmoghazy et al., 2015).

In several Arab countries, including Egypt, Iraq, Saudi Arabia, Kuwait, and Palestine, palm trees are widely grown. Dates, the primary product of these trees, have been consumed by humans for thousands of years.

DPL considered raw waste, it can be utilized in small ruminants feed to reduce costs and the nutritional value of DPL can be enhanced through methods such as chemical treatment, making silage, or crushing it to reduce volume (Shtayeh, 2022).

DPL can be effectively introduced to animal's ration. Previously, DPL introduced in ewes diet (Gouda et al., 2022), lambs diet (Mahrous et al., 2021), and also included in the rations of Friesian cows (Bahman et al., 1997). Additionally, DPL has been used in goat (Al-Suwaiegh, 2016).

DPL is a viable and useful option because it is simpler to dry and store than other by-products. Additionally, it is a locally accessible roughage that could be used in lamb feeding rations as a suitable substitute for barley straw.

Palm leaves are harvested through the pruning or cutting of old palm trees during maintenance and fruit harvesting stages. The production of palm tree midrib is approximately ten tons of dry matter per hectare per year (Loh, 2017).

Despite the abundant availability of palm leaves and their potential as green feed, their use in animal nutrition is still quite limited. This limitation is largely due to their low nutritive value; specifically, the high content of lignin contributes to reduce the digestibility and palatability (Suyitman et al., 2013).

DPL are available in massive quantities and have an important potential as forage feed. DPL are of low nutritive value that resulted in limited advantages. The nutritive analysis showed that it contains 54.12, 89.86, 8.51, 28.48, 59.11, 42.87, 24.69, 16.24 and (14.21%) of Dry matter content (DM), organic matter (OM), crude protein (CP), crude fiber (CF), neutral-detergent fiber (NDF), acid-detergent fiber (ADF), cellulose, hemi-cellulose and lignin, respectively (Ishida & Hassan, 1997).

Researchers mention that organic matter(OM) of DPL ranges from (80% to 92%) (El-Waziry et al., 2013; Pascual et al., 2000), crude protein (CP) highly fluctuates between (1.6% and 6.4%), (El-Waziry et al., 2013; Ziaei & Hosseini, 2009; Chehma & Longo, 2004; Genin et al., 2001; Pascual et al., 2000), they also note that crude fibre (CF) of DPL differs greatly between (24.1% and 42.1%) (Mahrous et al., 2021; El-Waziry et al., 2013; El-Bordeny et al., 2011; Chehma & Longo, 2004; Pascual et al., 2000).

In addition to that , the ether extract (EE) also varies between (0.75% to 3.5%) (Mahrous et al., 2021; El-Waziry et al., 2013; Chehma & Longo, 2004; Pascual et al., 2000), and the nitrogen-free extract (NFE) values ranges significantly from (47.6%) to (64.9%) (Mahrous et al., 2021; Pascual et al., 2000).

Furthermore, the percentage of total ash in DPL has fluctuated, with reported values ranging from (8.2%) to (12.9%) ( El-Waziry et al., 2013; El-Bordeny et al., 2011; Chehma & Longo, 2004; Genin et al., 2001) .

## **1.8 Performance of Livestock Fed with (DPL)**

### **1.8.1 Body Weight Gain**

Variable effects of feeding DPL on livestock performance were reported in previous research. However, microbial treatment of DPL had positive effect on overall body gain, feed conversion efficiency and weight gain /day (Elshahat et al., 2010).

However, that supplementation of DPL with enzymes did not have a significant affect the body weight of buffaloes (Kholif et al., 2022; Morsy et al., 2021).

Additionally, the daily gain was not significantly different between calves fed biological-treated DPL and those fed untreated rice straw (El-Rahman et al., 2014).

### **1.8.2 Feed Conversion Ratio (FCR)**

According to previous study, feed conversion analysis utilizing DPL revealed no appreciable variations across the tested rations of nursing goats (Aboul-Fotouh et al., 2017).

Another reports mention the possibilities to improve and enhance FCR of DP by-products by using biological treatments procedure (El-Banna et al., 2010; Gado et al., 2009; Allam et al., 2006; Fouad et al., 2002; Beauchemin et al., 1995).

On the other hand, the daily feed conversion of the control ration was clearly substantially lower than ration containing DPL, as demonstrated by earlier research (Peters et al., 2015).

It's important to note that some additional treatment could be of significant advantages such as the enzymatic treatment (Gado et al., 2009).

### **1.8.3 Nutrients Digestibility**

Its previously known that the biological treatment method enhanced the digestibility of nutrients, particularly crude fiber (CF), as a result of the degradation of crude fiber caused by biological treatments (Elenin et al., 2016).

Earlier researchers show increase in digestibility coefficients for CP, CF, and fiber fractions over a broad range of poor nutritive value sources treated by biological method ( Salama et al., 2019; Azzaz et al., 2013; Abo Omar & Omar, 2012; Fouad et al., 2002).

Its reported also that the digestibility coefficients (Dc) as percentages of nutrients were significantly higher ( $P<0.05$ ) in diet containing Alfalfa hay and chemically or biologically treated rice straw compared to control(El-Razik & Ayyat, 2012). Specifically, the improvements in (Dc) of dry matter were (10.18%, 7.77%, and 7.83%) for Alfalfa hay, chemically treated rice straw, and biologically treated rice straw, respectively, when compared to the control group. Corresponding increases in organic matter (OM) digestibility percentages were (17.46%, 20.34%, and 19.28%), respectively (El-Razik & Ayyat, 2012).

Furthermore, the enhancements in crude protein (CP) were noted at (46.8%, 38.6%), and (41.5%), respectively. The improvements in crude fiber (CF) digestibility percentages were (18.3%, 24.4%, and 33.0%), respectively, while the corresponding values for ether extract (EE) digestibility were (8.9%, 22.4%, and 6.2%) (El-Razik & Ayyat, 2012).

Additionally, the study on growing lamb demonstrated that the Dc for CF, EE, CP, NDF, ADF, hemi-cellulose, and cellulose in biologically treated roughages improved by (14.4%, 14.3%, and 10.1%), respectively, compared to the control group (El-Banna et al., 2010) .

#### **1.8.4. Blood Metabolites**

A study on goats fed banana by-products treated with the biological approach showed a significant rise in serum total protein levels, while serum globulin levels stayed unchanged (Azzaz et al., 2013).

Similarly, when exogenous *fibrolytic enzymes* were added to dairy cows' diets, the serum total protein concentrations increased significantly ( $P<0.05$ ); albumin and globulin concentrations did not change significantly (Peters et al., 2015). The experimental animals maintained normal conditions and performance throughout the study and seemed to be in good health (Peters et al., 2015). Moreover, serum cholesterol levels were not substantially changed by feeding rations containing (DPL), either with or without direct-fed microbial supplementation (Kholif et al., 2022; Morsy et al., 2021). Interestingly,

when compared to the other groups, the group that received rations containing tow grams of direct-fed microbial supplementation tended to have higher cholesterol levels.

Furthermore, its verified that biological treatments added to rabbit diets had no effect on the cholesterol concentration (Elshahat et al., 2010).

When compared animals fed treated and untreated rice straw, the animals fed diets containing biologically treated rice straw had non-significantly lower blood serum urea concentrations (El-Rahman et al., 2014).

likewise, no negative effects was observed on the kidney functions of growing rabbits from the biological treatments used (Elshahat et al., 2010).

Also it was observed that there was no meaningful increase in serum glucose concentrations in animals fed (DPL) silage (Kholif et al., 2022; Morsy et al., 2021). Similarly, it was noted that serum glucose levels in lactating goats receiving the tested rations showed no significant differences among all groups in the overall mean values (Aboul-Fotouh et al., 2017). However, higher glucose concentrations may indicate improved energy utilization and enhanced absorption of soluble carbohydrates through the ruminal wall into the bloodstream, resulting in increased availability of glucose (Aboul-Fotouh et al., 2017).

#### **1.8.5. Economic Efficiency**

Forages and cereal crops exhibit considerable seasonal availability. As a result, the significance of roughage as a feed resource is declining, while the use of cereals and agro-industrial by-products is on the rise ( Abo Omar, 2002; Abo Omar, 2001).

Recent investigation showed that many wastes are available in significant quantities (Zaazaa & Abo Omar, 2020; Ahmed & Abdallah, 2012; Abo Omar, 2002; Abo Omar, 2001) .

The high fiber and lignin contents limits the usefulness of palm leaves as depressed both palatability and digestibility (Ishida & Hassan, 1997). However, applying some upgrading protocols to these leaves could improve these characters. The upgrading protocols include physical and chemical processing techniques, biological treatment methods and mixed processing.

Efforts to enhance the digestibility of fibrous feeds should be undertaken to optimize nutrient utilization and feeding value of palm leaves (Suyitman et al., 2013). The use of palm leaves as a feed could be increased if leaves preserved in a proper way as ensiling. High-quality silage can be produced without additives, as noted earlier (Ishida & Hassan, 1997). Additionally, good silage quality can be achieved without additives if the plant material is ensiled under anaerobic conditions (Ishida & Hassan, 1997).

Efforts to improve the feed utilization of waste have centered on utilizing processing techniques, which can be physical, chemical, biological, or a mix of these methods.

Sodium hydroxide treatment is a method to improve palm leaves digestibility and intake (Mohanty et al., 2022).

However, more investigation is needed to find the proper upgrading method and if suitable to combine the alkali treatment with other combinations such as urea and pelleting.

Alkaline treatment is effective method for enhancing the microbial fermentation ruminal of ligno-cellulosic feedstuffs ( Ghasemi et al., 2014; Ahmadi et al., 2013).

Another treatment resulted in delignification and make lignocellulose swollen and porous (Hendriks & Zeeman, 2009).

A widely used chemical processing method for ligno-cellulosic materials is the dry spraying technique, which has been shown to effectively improve ruminal digestion of ligno-cellulosic (Jackson, 1977).

#### **1.8.6. Reproductive Performance**

It is necessary to examine the effect of inclusion of nonconventional feed ingredients to livestock rations on the reproductive performance of farm animals as these animals and their productivity is the backbone of food security.

The lambing percentage, conception rate, abortion, twin percentages, number of born lambs as well as period to conception, the long of gestation period and number of services/conception were studies by various research (Gül & Keskin, 2010; Atta & Khidir, 2006; Abu-Zanat et al., 2005; Kabaija et al., 1989).

## **1.9 Environmental Impact of Using Date Palm Leaves (DPL) as Fodder**

Utilizing Date Palm Leaves (DPL) as livestock feed offers significant environmental benefits, particularly in arid and semi-arid regions like Palestine. Semi-arid regions are famous for date palm cultivation and produce significant quantities of DPL, which are usually burned or discarded, and lead to environmental contamination and pollution along with loss of potential resources. Introducing these byproducts into animal feed ration not only contributes to solving the issue of fodder shortages but also plays a role in sustainable agricultural practices by using of agricultural residues (Kholif et al., 2022).

By using DPL in livestock feed ration, these by-products can become important and valuable resources and make a significant reduction in waste and environmental pollution and that is in line with the principles of eco-agriculture, where residues and are reused as input in the production system, which led overall to improve sustainability (Kholif et al., 2022).

Regardless that using DPL led to reducing waste quantities and pollution, DPL as fodder has several advantages to the environment. Using DPL minimizes the requirement for conventional feed crops like soybean, corn and wheat, which result in reduced use of land, water, and energy sources for production of animal feed (Kholif et al., 2022). Furthermore, replacing DPL with a part of imported feed ingredients in ration can reduce the pollution resolute from the carbon footprint associated with the transportation of these feed ingredients (Kholif et al., 2022). Moreover, using DPL as feed ingredients also helps avoid environmental degradation caused by how farmers are disposed of the large quantity of DPL, which usually leads to air pollution due to burning of leaves and soil contamination due to poor waste management system (Kholif et al., 2022).

On the other hand, the nutritional value of DPL as fodder depends on the method of processing. Raw, unprocessed DPL has low digestibility value because of its elevated fiber content, which ultimately leads to reducing the nutritional value of its use as animal feed (Kholif et al., 2022). DPL processed by ensiling with fibro-lytic enzymes and probiotics has been revealed to enhance the digestibility value and nutritional quality of DPL as a feed resource (Hamdon et al., 2022). It is worth noting that processing techniques not only improve the performance of animals but also play a significant role

in the sustainability and viability of livestock production systems by maximizing the use and effectiveness of local resources.

In summary, Using DPL as feed ingredients in livestock ration may represent a sustainable strategy to feed management in arid and semi-arid regions. DPL utilization helps in waste management, conserve resources, prevent environmental degradation, and develop sustainable agriculture systems.

### **1.10 Farmer Perception and Adoption of DPL Feeding**

The effective and successful adoption of alternative feed resources like DPL in animal diets depends mainly on farmers' perceptions, awareness, knowledge, insight, and eagerness to incorporate new practices into their traditional systems. In Palestine, agricultural lands are limited, water resources are decreasing with time, and feed availability is constrained. For these reasons, the incorporation of agro-waste such as DPL in animal feed presents an attractive, charming and cost-effective option. However, adoption of by-products alternative remains minimal and limited, primarily because of the large gaps in farmers awareness, technologies of processing, and perceived feed value and quality (Mohammed et al., 2020). Regarding DPL, most of livestock farmers are not fully understood of its the nutritional potential and value as animal feed and how can be enhance DPL digestibly and nutritional quality through methods such as ensiling, chemical treatment, or mixing it with other by-products (Hamdon et al., 2022).

It is worth noting that in some cases traditional beliefs, old information, and the absence of modern technologies discourage innovation or limit it, especially among older or small-scale livestock farmers. Moreover, fluctuation in palm residues quantities and lack of clear guidelines on safe and optimum inclusion rates contribute also to livestock farmers' hesitance (Zahra & Al-Sahaf, 2019).

In arid and semi-arid regions, research and studies have revealed that field scenes, feeding trials, cooperative-led initiatives and government extension programs greatly increase the possibility of adoption of by-products and non-traditional animal feeds (Al-Jaloud et al., 2021).

In Palestine, supporting livestock farmers with specialized training programs, providing access to modern feed processing tools easily, and confirming the accuracy of field data

on livestock performance after fed diet containing DPL could increase confidence in its use. In addition, involving local universities and agricultural cooperatives in awareness campaigns would strengthen the feedback loop between research and field practice. Finally, wider adoption of DPL feeding depends on the combining scientific knowledge with practical experience, ensuring that farmers view it as a practical solution to scarcity and high costs of feed, rather than a risky experiment.

### **1.11 Legal and Policy Framework on Fodder Use in Palestine**

In Palestine, as we mention earlier the adoption of alternative feed resources, including the use of DPL, are greatly influenced by the legal and institutional frameworks governing livestock and feed production.

This country faces critical challenges in ensuring feed security for livestock sector and because of political instable condition, limited access to arable land, and dependency on highly cost imported feed (FAO, 2020). At the present time Palestinian government represent by ministry of agriculture has voiced support for the diversifying of animal feed resources. However, there is still no clear vision and national strategy to integrate agricultural by-products like DPL in animal feed and diets (ARIJ, 2021). Current laws in Palestine tend to focus on crop production and use of lands instead of integration of agricultural waste in feeding system, resulting in a gap that limits the scale-up of such practices. Furthermore, the lack of subsidies, technical guidelines, and extension services regarding non-conventional fodder crops inhibits widespread adoption among farmers (Al-Karablieh et al., 2020). International organizations like FAO and several local NGOs have initiated pilot projects promoting sustainable livestock feeding practices, including training workshops and small-scale feed innovation trials. However, these efforts remain fragmented and underfunded, with limited impact on national policy direction. Additionally, trade restrictions and border control policies have created fluctuations in the availability and cost of conventional feed, further highlighting the urgent need for a resilient, local feed policy framework. Establishing legal mechanisms to recognize, promote, and regulate the use of agro-waste like DPL could contribute to improving feed self-sufficiency, reducing costs, and mitigating environmental degradation. To this end, coordinated action among policy-makers, researchers, and farmer cooperatives is essential to develop an inclusive legal framework that supports alternative fodder integration into mainstream livestock systems in Palestine.

### **1.12 Seasonal Availability and Storage of DPL**

The seasonality and fluctuation in availability of DPL poses a great challenge for using it as a consistent livestock feed source. In Palestine, DPL is primarily produced during the spring and autumn, the seasons of pruning palm trees. As a result of that, huge quantities become on hand in short periods, which leads to surplus in DPL during harvesting season and shortage during other seasons. Without suitable storage procedures and conditions, DPL may decay and lose its nutritional value due to moisture content, microbial growth, or pest damage. Modern storage techniques, like air-drying, chopping, balling, or ensiling with enhancer additives like urea, probiotics or molasses, can help preserve DPL quality and extend shelf life. Methods and techniques like these make DPL available and usable throughout the whole year, improve its quality availability and also decrease dependence on imported and traditional animal feed sources. Furthermore, training and encouraging livestock farmers to adopt simple, low-cost methods for treating DPL, especially through government extension services or cooperative support, may improve long-term sustainability and increase the use of DPL in livestock diets (Hamdon et al., 2022; Kholif et al., 2022).

## Chapter Two

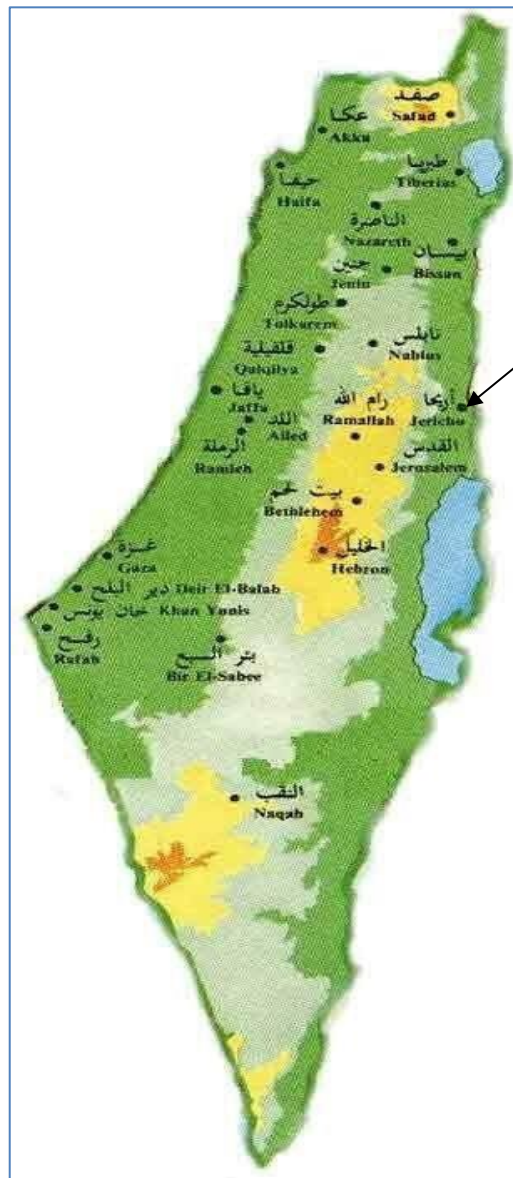
### Materials and Methods

#### 2.1 Study Location

The experiment was carried out on a private crossbreed sheep farm (300 head), in Al-Auja village / Jericho city / Westbank/ Palestine. This farm was selected because the farmer is interested in adopting modern agricultural management techniques and his farm is operating under semi-intensive systems.

**Figure 1**

*Geographic location of sheep farm in Palestine*



## **2.2 Date Palm Leaves (DPL) and its various forms**

Fresh DPL were collected from various lands in the Jordan Valley, Palestine, and dried under the sun (Hamdon et al., 2020). Following this, the DPL has some processing to use it in various forms as treatments.

### **2.2.1 Chopping DPL**

Palm Leaves were sourced from palm farms adjacent to the experimental site. They were collected immediately after pruning. As the material was still green and had a high moisture content, it was sun-dried for 10 days. Subsequently, the dried fronds were chopped into small pieces (approximately 2-3 cm) using a chopping machine (specifically, a Chapalina machine) (Figure. 2), Following this preparation, the material was subjected to three distinct treatments that were utilized in the experiment. The first treatment involved using the dried, chopped palm fronds directly. The second treatment utilized the palm fronds after ensiling. The third treatment involved treating the palm fronds with NaOH.

### **2.2.2 Silage DPL**

After chopping the DPL, the ensiling process was conducted using 70 kg capacity drums, where DPL were placed in it in layers. Between these layers, crushed corn grains and sugar were added to facilitate fermentation. A hydraulic press was utilized to compact the contents within the drums and expel air. The drums were then sealed tightly. The resulting silage was used after maturation, which occurred after approximately 45 days. (Figure. 3).

### **2.3.3 Alkali DPL**

The chopped DPL treated with a (5%) sodium hydroxide solution (NaOH), (Figure. 4). Prior to ensiling, the moisture content, initially at 100 g/kg of fresh matter, was elevated to about 400 g/kg by adding the alkaline solution.

Biological treatments are essential for the degradation of lignocellulosic by-products into their component parts (lignin, cellulose, and hemicellulose) thus enhancing the crude protein content. The swelling of cell walls improves the accessibility of ruminal microbial enzymes to cellulose and hemicellulose, which in turn can increase the voluntary intake of roughages. While enzyme treatment methods for the enhancement of poor-quality

forages and roughages remain underutilized, they hold significant promise for future application (Lindblom et al., 2018).

In this study, a (5%) NaOH solution was prepared by dissolving one kilogram of sodium hydroxide (NaOH) in 25 liters of water. This solution was utilized to soak 25 kilograms of raw dried palm leaves (DPL) for a duration of two hours. Following the soaking process, the treated materials were allowed to dry before being placed on a plastic sheet for subsequent use. It is imperative to turn the materials daily to ensure thorough drying and to prevent the growth of molds and fungi. The alkali-treated materials were then fed to ewes after a maturation period of two weeks (Jayanegara, 2015).

**Figure 2**

*Chopping of DPL*



Note: A: Chapalina Machine; B: Chopping of DPL; C: Drying of DPL

**Figure 3**

*Silage making using DPL*



DPL were prepared in three forms: ensiled DPL, chopped DPL and DPL alkali treated. The materials were filled into 50 kg bags (40×70cm) for each form of DPL.

**Figure 4**

*The alkali treatment of DPL*



## **2.4 Ewes and Management**

### **2.4.1 Experimental Design for Experiment One**

Twenty Crossbreed female ewes between 6-7 months were chosen for this study, they were randomly assigned to four groups of five each, each ewe functioned as a replicate within the group. The experimental ewes were treated for parasites and given the enterotoxaemia vaccine. They were also vaccinated against *Clostridium perfringens* types C and D. All ewes were ear-tagged throughout the 30-day experiment. Ewes were individually housed in semi-open system with soil/earth floor pens, each measuring 1.5 m<sup>2</sup> per sheep. Each pen was equipped with a feeder and a bucket to provide freshwater ad libitum (Figure. 5).

**Figure 5**

*Pens of ewe lambs*



Fixed amount of Date Palm Leaves (DPL) with different treatments was fed to the experimental ewes.

The control ewes were fed traditional ration composed of (70%) concentrated feed plus (30%) of wheat hay (G1). Experimental ewes were fed DPL as following:

G2 ewes were fed chopped DPL at level of (15%) on behalf of wheat hay. G3 and G4 ewes were fed ensiled and alkali treated DPL at level of (15%) of the diet (table 2).

### **2.4.2 Experimental Design for Experiment Two**

A total of 28 Cross breed of milking ewes at 3-4 years of age were selected for this part, were divided into 4 groups with 7 ewes for each group. Each ewe considered as a replicate.

The ewes underwent treatment for both internal and external parasites, received an injection of the enterotoxaemia vaccine, and were vaccinated against *Clostridium perfringens* types C and D. All ewes were numbered using ear tags for data recording throughout the 60-day study period.

Wool shearing was performed on all crossbred ewes to eliminate external parasites and help them acclimate to temperature changes. Feed was provided to the ewes twice daily, at 7:00 AM and 6:00 PM, with daily records kept. A 7-day adaptation period preceded the experimental phase, during which mineral blocks and water were provided ad libitum. Rations were formulated in accordance with the (National Research Council (U.S.), 2007) recommendations (Table 2; Figure. 6).

Lambs and ewes were randomly assigned to groups, with each group fed according to their nutritional requirements, as outlined in the (National Research Council (U.S.), 2007) tables.

Chemical composition and representative sample of all feed ration were analyzed in National Agriculture Research Center (NARC).

**Table 2**

*Ingredients (%) and Chemical Composition of the Rations Given to Ewes in Experiments One and Two*

Ingredients %	G1	G2	G3	G4
Concentrated feed 16% CP	70	70	70	70
Wheat hay	30	15	15	15
Chopped Palm leaves	0	15	0	0
Silage palm leaves	0	0	15	0
Alkali Palm leaves	0	0	0	15
Total	100	100	100	100
Chemical composition%				
Dry matter	87.98	82.34	86.89	87.01
Crude protein	15.68	16.48	16.53	16.10
Ether extract	3.18	3.23	3.24	3.18
Crude fiber	9.07	8.20	7.87	8.97
ADF	6.20	7.20	6.81	8.20
NDF	14.67	15.22	15.28	15.72
Ash	6.15	6.58	6.57	6.81
Calcium	1.11	1.21	1.15	1.13

Treatments: (G1: control group; G2:15% chopped DPL; G3: 15% silage DPL; G4: 15% alkali DPL)  
ADF: Acid Detergent Fiber.  
NDF: Neutral Detergent Fiber.

**Figure 6**

*Pens of mature ewes*



Diets were formulated to meet and satisfy the nutrient requirements of ewes in lactation stage according to (National Research Council (U.S.), 2007) recommendations . The ewes were individually weighed on a digital scale monthly. Daily diet samples were collected randomly and stored for chemical analysis after being dried at 60 °C in a forced-air oven for 48 hours (Latimer, 2023).

## **2.5 Feed Intake Record and Apparent Digestibility of Nutrient**

Digestibility trials were performed in the final ten days of the feeding trials (experiments 1 and 2). Each day, the amounts of feed offered to animals and orts were recorded.

The daily feed intakes of concentrate feed and DPL were determined during the sample collection phases by deducting the orts from the feed offering from the day before. Each ewe's ort collection was carried out separately, then combined prior to sampling. Additionally, individual fecal samples from all ewes were gathered twice daily, at 07:00 AM and 15:00 PM hours. These fecal samples were then dried at 60 °C in a forced-air oven for 48 hours and pooled by ewe for further analysis. The samples were stored for subsequent evaluation.

A Wiley mill was used to grind composite samples of dried feed, orts, and excrement so they could fit through a 1mm screen. After that, these samples were examined for DM, ash, nitrogen, and EE using the formal procedures described by (Latimer, 2023). NDF was measured with the inclusion of alpha-amylase and sodium sulfite, with results expressed exclusive of residual ash.

Additionally, ADF was reported exclusive of residual ash, in accordance with AOAC guidelines (Latimer, 2023).

## **2.6 Blood sample collection and Analysis of Serum**

Blood samples were collected from four ewes in each experimental group during the early morning, just before feeding, on the final day of the feeding trials (Experiments one and two).

Ten milliliters of blood were drawn from the jugular vein four hours post-feeding using sterilized, dry tubes that did not contain anticoagulants.

All samples were then subjected to centrifugation at four thousand times gravity for twenty minutes at four degrees Celsius.

The serum was carefully transferred into sterilized two-milliliter Eppendorf tubes and subsequently frozen at minus twenty degrees Celsius for future analysis.

## **2.7 Management of reproductive performance of ewe female lambs**

### **Experiment 1**

Two mature, fertile rams that appeared in good health status were selected randomly for inclusion in a randomized block design experiment alongside the ewes.

Each morning, ewes assigned to each treatment group were exposed to their ram for duration of three hours. During this time, we closely monitored the ewes for signs of estrus and willingness to mate. Ewes displaying these signs were then re-exposed to the ram in the evening to facilitate successful mating, and the date of service was recorded.

Daily exposure to the ram continued until the ewes' exhibited signs of pregnancy, characterized by the development of udder and an enlarged abdomen.

Following lambing, the ewes were exposed to the ram again one week after giving birth. Gestation and lambing intervals were subsequently calculated. After the lambs were dried, their birth weights were promptly recorded, as outlined previously (Atta & Khidir, 2006).

## **2.8 Milk Analysis**

Milk yield was recorded biweekly at 08:00 AM through manual milking, consistently performed by a trained technician to ensure accuracy and minimize variability due to handling. To standardize milk accumulation, lambs were separated from their dams for a period of 12 hours prior to each milking session. This separation typically occurred overnight and was essential for obtaining a reliable estimation of daily milk production. The milk yield obtained during the morning milking was then extrapolated to estimate the total yield over a 24-hour period.

For milk composition analysis, a 125 mL sample was collected from each ewe during each milking session. These samples were immediately stored under appropriate

conditions and subsequently analyzed using a Lacto Scan milk analyzer. This device provided detailed quantitative data on key milk constituents, thereby enabling a comprehensive evaluation of milk quality and composition.

## **2.9 Chemical Analysis**

The chemical composition of the experimental diets and feed refusals was analyzed to determine the nutritional profile consumed by the animals. Initially, all feed and refusal samples were dried overnight in a forced-air oven maintained at 105°C to determine their final dry matter (DM) content, following the standard procedures outlined by the Association of Official Analytical Chemists (AOAC) (Horwitz, 2006). The crude protein (CP) content was determined by measuring nitrogen content using the Kjeldahl method and multiplying by a factor of 6.25 to estimate total protein.

Neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents were analyzed using the ANKOM2000 fiber analyzer system, which provides a reliable and efficient method for fiber fraction determination. Ether extract (EE), representing the lipid content of the samples, was assessed using the Soxtec extraction technique, a commonly used method for evaluating fat content in feedstuffs.

Dry matter intake, as well as the intake of individual nutrients, was calculated by subtracting the amount of feed refused from the total amount of feed offered to each animal. This allowed for a more accurate assessment of actual nutrient consumption. Additionally, the metabolizable energy (ME) content of the diets was estimated using standardized tabular values provided by the National Research Council (NRC) guidelines (National Research Council (U.S.), 2007), which are widely recognized for formulating diets and estimating energy values in animal nutrition studies.

## **2.10 Statistical Analyses**

All statistical analyses were performed to evaluate the effects of dietary treatments on the measured response variables. In the statistical model, ewe lambs were considered as a random effect, reflecting the inherent biological variability among individual animals, while the dietary treatments were considered fixed effects, as these were the primary factors of interest in experimental design.

was selected due to its suitability for analyzing data from experiments with both fixed and random effects, especially in designs with repeated measures or unbalanced sample sizes. The mixed model used in the analysis can be represented as:

$$Y_{ij} = \mu + T_i + R_j + \epsilon_{ij} \quad 1$$

Where:

- $Y_{ij}$  is the observed response variable,
- $\mu$  is the overall mean,
- $T_i$  is the fixed effect of the  $i^{\text{th}}$  treatment,
- $R_j$  is the random effect of the  $j^{\text{th}}$  ewe lamb,
- $\epsilon_{ij}$  is the residual error term assumed to be normally distributed with mean zero and constant variance.

The study employed a rigorous statistical framework to ensure the accuracy and reliability of its findings.

Key model assumptions, such as the normal distribution of residuals, equal variances across groups, and independence of errors, were carefully assessed using both visual inspection techniques (residual plots) and formal statistical tests. Where these assumptions were not met, appropriate data transformations or alternative variance structures were considered to address potential violations.

Statistical significance was determined using a p-value threshold of 0.05. When significant treatment effects were observed, comparisons between treatment means were conducted using the least squares means (LSMEANS) method within the MIXED procedure. This approach accounted for the unbalanced nature of the data and provided adjusted means for more accurate comparisons. To control the increased risk of Type I errors associated with multiple comparisons, Tukey's Honestly Significant Difference test or Bonferroni adjustment were applied where appropriate.

This comprehensive analytical strategy ensured that treatment comparisons were conducted rigorously, accounting for both between-animal and within-animal variability, thereby enhancing the reliability and interpretability of the study's conclusions.

## Chapter Three

### Results and Discussions

#### 3.1 The Chemical Composition of Date Palm Leaves

Table three shows the chemical composition of Date Palm Leaves (DPL) compared to the original feed ingredients, specifically, concentrate feed and wheat hay. Our research focused on comparing DPL with wheat straw. Byproducts of DPL were found to have higher (CP) and (ADF) levels than wheat straw, while their (DM) and ash contents were similar.

On the contrary, (DPL) had less content of (NDF) and (CF). According to Khalifa (2019), DPL contained higher amounts of DM, OM, CP, CF, and EE compared to wheat straw. However, the ash content in DPL was lower than that in wheat straw, and the non-fibrous carbohydrates were almost equal in both feed sources.

**Table 3**

*Nutrient chemical composition of feed ingredients used in various rations*

Feed/feed ingredient	Feed nutrient chemical composition %								
	CP	Fat	CF	Ca	P	DM	ADF	NDF	Ash
Concentrated feed	18	3.5	6	1.3	0.6	87	5.5	11	6
Wheat Hay	4.1	7.2	24.4	0.16	0.04	92.9	9.7	52	10
DPL silage	5.5	3.1	35.8	0.1	0.4	37.4	27	52	8.8
DPL treated with 5 % NAOH	9.6	2.9	30.5	0.1	0.1	90.4	24	49	11.7
Chopped DPL	7.4	2.8	22.6	0.1	0.1	92.1	28	55	10

The DPL crude protein was approximately 34% higher than wheat straw.

CP: Crude Protein; CF: Crude Fiber; Ca: Calcium; P: protein; DM: Dry Matter; ADF: Acid Detergent Fiber; NDF: Neutral Detergent Fiber.

Our study revealed that the crude protein (CP) content in date palm leaves (DPL) was higher than the levels reported in previous investigations conducted by (El-Waziry et al., 2013; Medjekal et al., 2011; Kafilzadeh et al., 2009). This indicates that the treatment methods applied in our study, which included both ensiling and alkali treatment, may have contributed to an improvement in the nutritional profile of DPL, particularly its protein content. These findings suggest that processing techniques can significantly influence the nutrient composition of agricultural by-products, potentially enhancing their suitability as feed resources.

Regarding crude fiber (CF) content, our results showed that DPL had a lower (CF) percentage (22.6%) in comparison to wheat straw (24.4%). However, in another instance, DPL demonstrated a higher (CF) value (43.01%) relative to wheat straw (41.66%), as reported by (Mahmoud and Khalifa, 2019). This inconsistency may be attributed to differences in sample origin, treatment methods, or analytical techniques. Furthermore, El-Bordeny et al. (2011) documented a lower (CF) content of (38.21%) when DPL was incorporated into rabbit rations, which supports the variability observed across studies. Comparable (CF) values were noted by (Mahrous et al., 2021), who reported a fiber content of (42.14%), while El-Waziry et al. (2013) recorded an even lower Figures of (34.9%). Both these values are below those found in our study, suggesting that our treatment approach may have contributed to a modest elevation in CF levels. The increase in CF could also be influenced by varietal differences in the plant material or by environmental conditions affecting plant growth and composition.

In terms of ether extract (EE) content, the DPL in our study exhibited a value of (2.8%), which was substantially lower than that of wheat straw, recorded at (7.2%). This disparity highlights a notable variation in lipid content between the two materials. Moreover, our EE findings contrast with those reported by several previous studies: Khalifa (2019) reported (2.31%), Pascual et al. (2000) recorded (2.1%), Chehma and Longo (2004) observed (2%), and El-Waziry et al. (2013) noted a higher value of (3.5%). These variations further underline the influence of processing methods, geographical origin, and possibly cultivar type on the nutritional composition of DPL. Overall, the nutritional characterization of DPL in our study supports its potential as a viable roughage alternative in livestock feeding systems, particularly when appropriately treated to enhance its feed value.

## 3.2 Ewe lamb's performance

### 3.2.1 Body weight gain

Table Four displays the results of the feed conversion ratio, average daily gain, overall gain, initial and final body weight.

**Table 4**

*Performance of ewe lambs fed various forms of date palm leaves (DPL) and fattening costs*

	G1	G2	G3	G4	<i>p-Value</i>
The amount of Feed intake(kg)	240.80	240.80	240.80	240.80	
Initial weight(kg)	38.30	40.10	42.00	39.80	0.12
Final weight(kg)	44.00	45.34	47.00	46.20	0.74
Total weight gain(kg)	5.70	5.24	5.00	6.40	0.62
ADG (gram)	203.50	187.14	178.57	228.57	0.62
FCR (kg/ DM intake)	2.30	2.17	2.070	2.65	0.81
Cost of gain (NIS)	163.70	178.20	183.00	173.40	N/A
Cost / lamb, Nis	818.70	890.9	915.00	866.90	0.89
Cost/kg ration, NIS	3.40	3.70	3.80	3.60	N/A
Feeding days	28	28	28	28	N/A

Treatments: G1: control; G2: 7.5% ground DPL; G3: 7.5% silage DPL; G4: 7.5% alkali treated DPL.

ADF: Average Daily Gain; FCR: Feed Conversion Ratio

Data were reported as a means.

N/A= Not applicable

The average body weight (BW) and average daily gain (ADG) of lambs given different diets supplemented with various types of DPL are shown in the results. These metrics were not significantly impacted by feeding DPL. Researchers observed similar findings (Gouda et al., 2022). However, microbial and enzymatic supplements to meals improved average weights and ADG, which is the reverse of our findings.

Earlier research Beauchemin et al. (1995) suggested that improved digestibility, which raises rumen microorganisms' availability of energy and nutrients, might be the cause of the rise in live weight brought about by enzyme supplementation. Moreover, prior research in large ruminants discovered that enzymes significantly enhanced microbial protein production and improve the overall microbial population in the rumen (Gado et al., 2009).

Our results and findings are consistent also with (Azzaz et al., 2013; Gado et al., 2009), who revealed that adding exogenous fibro-lytic enzymes to ruminants diets improved feed conversion ratio and enhance the live weight growth.

Other study also have demonstrated that there are no significant differences appreciable in the beginning and final body weight the goats given DPL in the ration and control diets, indicating that the introducing DPL in experimental diets met the goats nutritional requirement for both production and maintenance stage (Al-Suwaiegh, 2016). These findings align with study by (Suliman et al., 2015), who found that sheep lambs gained more body weight as the amount of pulverized date seeds in their diet rise to 30%. Additionally, in a similar study, researcher have discovered that lambs performance enhanced when its fed a ground date seeds (Mustafa, 2014).

Conversely, (Abdel-Fattah et al., 2012) discovered that lambs final weight was decreased when their diet contained 30 percent ground date seeds. The discrepancies in total body weight increase found in this study compared to prior investigations may be attributable to changes in date types utilized, date pit inclusion levels in meals, animal breeds involved, and the animals' physiological reactions to the date pits.

### **3.2.2 Feed Conversion Ratio (FCR)**

Our investigation supports the findings (Gado et al., 2009), who found that adding exogenous *fibrolytic enzymes* to ruminant diets boosted live weight growth and FCR.

Our study found no significant difference in FCR (dry matter intake per gram of weight increase) between the experimental diets and the control group. Ewes given date palm leaves, whether untreated or with direct-fed microbial additions, showed considerable improvement in DMI per unit gain.

Specifically, improvements of (12.8%, 18.0%, and 24.2%) were observed in the respective experimental groups compared to the control group.

**Table 5**

*Performance of milking ewes after fed on various forms of (DPL), and feeding cost*

	G1	G2	G3	G4	<i>p-Value</i>
Feed intake(kg)	792.00	789.00	780.00	781.00	
Initial weight(kg)	49.64	53.86	48.00	48.71	0.13
Final weight(kg)	56.64	59.86	53	53.71	0.75
Total weight gain(kg)	7.00	6.00	5.00	5.00	0.61
ADG (gram)	116.60	100.00	83.30	83.30	0.61
FCR (kg/ DM intake)	3.77	3.60	4.20	4.70	0.82
Cost of gain (NIS)	50.00	62.90	75.70	75.80	N/A
Cost / lamb, Nis	350.00	377.00	378.80	369.00	0.88
Cost/kg ration, NIS	3.10	3.35	3.40	3.40	N/A
Feeding days	60	60	60	60	N/A

Treatments: G1: control group; G2: chopped DPL; G3: silage DPL; G4: Alkali

ADG: Average daily gain, FCR: Feed conversion ratio

N/A= Not applicable

### **3.3 Economic efficiency**

#### **Experiment 1:**

Table four shows that the form of DPL did not increase economic efficiency. El-Tahan et al. (2013) found that animals fed treated agricultural wastes had greater economic feed efficiency (13.68%) than those given untreated rice straw (11.76%). Furthermore, chemical and biological treatments of agricultural wastes reduced the cost of feed necessary to produce one kilogram of live body weight growth by (15.54% and 16.82%), respectively, when fed to lambs (Abdelhamid et al., 2009; Fouad et al., 2002).

A study by Abdel-Azim et al. (2011) observed also a similar findings, it was found that treated ingredients had a lower feed cost per kg body weight growth and were more economically efficient than untreated.

Substitution alfalfa hay by (10% and 20%) palm leaves resulted in a steady drop in total feed cost; however, (30%) did not significantly reduce feed cost as a result of increased feed consumption in this group. This may be due to the not significant change that was found in feed consumption in tandem with the progressive increase in palm leaf %, which led to a decrease in the cost of kg feed.

### **Experiment 2:**

The economic efficiency was not improved by form of DPL (Table 5). Similar findings were observed by (El-Tahan et al., 2013), who reported that the economic feed efficiency for animals fed treated agricultural wastes was higher (13.68%) compared to those fed untreated rice straw (11.76%).

Furthermore, the chemical and biological treatments of agricultural wastes led to a reduction in the cost of feed required to produce one kilogram of live body weight gain by (15.54% and 16.82%), respectively, when fed to lambs (Abdelhamid et al., 2009; Fouad et al., 2002). Also reported similar results in study of evaluation biological treatments in some agricultural by-products (Abdel-Azim et al., 2011).

A study by (El-Tahan et al., 2013); found that biological treatments on palm fronds resulted in higher economic efficiency compared to control groups. Adding palm fronds led to a gradual drop in the cost per kilogram of body weight growth. However, treated rice straw had a higher overall feed cost than untreated rice straw.

Moreover, El-Rahman et al. (2014); Abdelhamid et al., (2009) and Fouad et al., (2002) discovered that treating waste products chemically and biologically can lower the cost of feeding for a kilogram of live body weight growth.

In line with these findings, (Abdel-Azim et al., 2011) observed that the least feed cost per kilogram of body weight gain and improved economic efficiency were associated with treated feed ingredients compared to untreated ones.

### 3.4 Digestibility

#### Experiment 1

Including DPL in feed at any forms did not have significant effects ( $P > 0.05$ ) on the digestibility of crude protein and crude fat (Table 6). However, the digestibility of crude fiber was lower in the diets containing DPL in various forms (ensiled, alkali treated and chopped), with the control group showing a digestibility rate of (59%).

Similarly, results were reported by (Gouda et al., 2022; Kholif et al., 2022).

**Table 6**

*Dry matter content and digestibility of nutrient in ewe lambs fed various forms of (DPL) %.*

Group	CP	Fat	Fiber	DM
G1	59.34	60.94	58.24	66.40
G2	57.28	59.68	53.60	66.32
G3	59.25	58.00	56.00	66.34
G4	61.40	58.44	52.60	66.10

Treatments: G1: control group; G2: chopped DPL; G3: silage DPL; G4: Alkali treated DPL.  
CP: Crude protein; DM; Dry matter

#### Experiment 2

The forms of DPL had no meaningful effect on nutrient digestibility in lactating ewes (Table 7).

**Table 7**

*Dry matter and nutrients digestibility in lactating ewes fed on various forms of (DPL) %.*

ITEM	G1	G2	G3	G4
CP	60.20	46.20	39.3	42.40
Fat	61.80	61.10	55.00	55.50
Fiber	59.00	44.60	47.00	53.60
DM	67.50	67.40	66.30	68.10

Treatments: G1: control group; G2: chopped DPL; G3: silage DPL; G4: Alkali treated DPL.  
CP: Crude protein; DM; Dry matter

Adding lactic and malic acids to silage can increase feed intake by improving ruminal fermentation and digestion in sheep. Improved milk production may be attributed to increased feed intake and nutritional digestibility.

Supplementation of organic acids to Holstein cows' total mixed diet has also been shown to boost feed intake ,previous research found a (3.7%) reduction in feed intake when nursing cows were given 50 g of malic acid per day (El-Zaiat et al., 2019).

In contrast, another study by Li et al. (2018) discovered no significant influence on daily feed consumption in steers fed a meal comprising corn grain steeped in a 1% lactic acid (w/v) solution for 48 hours.

Despite these variations between researches, El-Zaiat et al. (2019) demonstrated increased dry matter (DM) and organic matter (OM) digestibility in lactating cows supplemented with malic acid. Additionally, supplementation with fumaric acid at (2%) of the diet in sheep increased the activities of ruminal xylanases and amylase (Pal et al., 2015). Malic acid has also been associated with a dose-dependent reduction in protozoal populations in the rumen, as reported by (Genç et al., 2020; Ebrahimi et al., 2015).

The reduction in ruminal protozoa has been associated with increased bacterial populations, as protozoa are the primary predators of ruminal bacteria (Newbold & Rode, 2006). This shift in microbial dynamics may partially explain the observed improvements in digestibility. Lactic acid treatment was found to enhance dry matter (DM) digestibility more effectively than malic acid, possibly due to differences in the chemical structure of the organic acids, particularly their chain lengths (Li et al., 2018).

It was suggested that the effect of organic acids on ruminal bacteria is influenced by their chemical composition, with Gram-positive bacteria being more sensitive to long-chain acids and Gram-negative bacteria being more affected by acids with fewer than eight carbon atoms (Genin et al., 2001). These differences in carbon chain length may help explain the variations in DM digestibility between lactic and malic acids.

Unexpectedly, the effects of organic acid treatments on fibre digestibility were weak. While organic acids have the potential to enhance fibre digestibility by removing hydrogen (H<sub>2</sub>) from the rumen (Newbold & Rode, 2006), this effect was not consistently observed. Similar findings were reported by (Ebrahimi et al., 2015), who found that malic acid had no significant impact on fibre fraction digestibility in calves. Additionally, it was observed that organic acids did not affect the populations of *Fibrobacter succinogenes* and *Selenomonas ruminantium*, two key bacterial species involved in fibre digestion (Li et al., 2018). These findings highlight the complex and variable effects of organic acid supplementation on ruminal fermentation and digestion.

### **3.5 Blood metabolites**

#### **Experiment 1**

Table eight shows that the analysis of blood parameters in lambs which fed on various (DPL) forms are not statistically significant differences and that according to (DPL) form consumed.

The lambs which consuming a biologically treated rice straw exhibited a marginally lower serum urea concentration compared to those fed untreated rice straw, which confirming the results which reached by (El-Razik & Ayyat, 2012).

Total protein concentrations in the current study ranged from 5.79 to 6.72 mg/dl, aligning with the normal range established for sheep (6 to 7.5 g/dl) and consistent with data reported by (Gouda et al., 2022). Similarly, albumin levels (2.96 to 3.06 g/dl) fell within the accepted norm of 2.7 to 3.7 g/dl (Aiello et al., 2016). Globulin concentrations (2.73 to 3.68 g/dl) were also within the expected range for sheep (3.2 to 5 g/dl) as (per Aiello et al., 2016).

**Table 8***Blood performance of ewe lambs (experiment 1)*

Group	Albumin (g/dL)	Total protein (g/dL)	Glucose (mg/dL)	Cholesterol (mg/dL)	Triglyceride (mg/dL)	AST-GOT (U/L)	ALT-GPT (U/L)	Bun (mg/dL)	Urea (mg/dL)	Globulin (g/dL)
G1	3.52	6.41	69.00	59.10	36.10	98.35	14.33	28.10	60.57	2.85
G2	3.31	6.02	66.10	58.10	22.90	89.10	17.20	23.00	49.00	2.66
G3	3.39	6.40	57.20	59.00	20.70	92.90	20.27	23.30	49.00	3.01
G4	3.31	6.59	55.59	58.00	23.20	106.93	20.27	29.00	46.83	3.22
P-value	0.520	0.31	0.44	0.937	0.085	0.651	0.781	0.722	0.722	0.42

Treatments: G1: Control group; G2: Chopped DPL, G3: Silage DPL; G4: Alkali treated DPL.

AST-GOT: Aspartate Aminotransferase; ALT-GPT: Alanine Aminotransferase; Bun: Blood Urea Nitrogen

**Experiment 2**

Table nine presents the findings on various blood metabolites in the experimental groups.

**Table 9***Blood parameters of lactating ewes (experiment 2)*

Group	Albumin (g/dL)	Total protein (g/dL)	Glucose (mg/dL)	Cholesterol (mg/dL)	Triglyceride (mg/dL)	AST-GOT (U/L)	ALT-GPT (U/L)	Bun (mg/dL)	Urea (mg/dL)	Globulin (g/dL)
G1	3.56	6.42	67.00	58.00	36.30	98.37	14.43	28.30	60.57	2.86
G2	3.35	6.05	66.30	59.00	23.00	90.10	17.30	23.00	49.03	2.68
G3	3.42	6.42	57.30	60.00	20.70	93.70	20.47	23.50	48.00	3.00
G4	3.36	6.61	55.70	59.00	23.30	107.23	20.47	23.00	47.83	3.24
P-value	0.510	0.280	0.414	0.949	0.080	0.644	0.776	0.717	0.718	0.405

Treatments: G1: control group; G2: chopped DPL; G3: silage DPL; G4: Alkali treated DPL.

AST-GOT: Aspartate Aminotransferase; ALT-GPT: Alanine Aminotransferase; Bun: Blood Urea Nitrogen

Blood parameters and serum biochemistry is considered an important things to determining the effects of non-traditional feed ingredients on animal health (Ibrahim & El-Sayed, 2016).

In a study prepared by (Abdel-Fattah et al., 2012), higher inclusion of (DPL) in the diet resulted in a significant increase ( $P < 0.05$ ) in blood levels, likely due to the presence of soluble carbohydrates and digestible nutrition's.

The protein and albumin levels in this research were within the normal range, showing that there were no anti-nutritional substances present that might impede food absorption in the small intestine, implying good hepatocyte function. This is consistent with studies by (Gouda et al., 2022; Azzaz et al., 2013), who found that integrating date palm leaves into rations had no significant effect on blood concentrations. The biological treatments applied to DPL appeared to enhance the measured parameters.

Also, it was found that biological therapies had no negative effect on renal function in developing rabbits (Elshahat et al., 2010). Furthermore, Kholif et al., (2022); Gouda et al. (2022); Morsy et al. (2021) and Allam et al. (2006) found that biological therapies raised serum total protein, urea, glucose, and AST in goats and lambs.

Lamb fed diets containing treated rice straw, either chemically or biologically treated, had greater blood total protein, albumin, urea, and AST levels. The biological therapy had no effect on serum globulin levels (El-Razik & Ayyat, 2012).

Additionally, It was found that enzymatic treatments had no effect on serum total protein, albumin, globulin, albumin/globulin ratio, urea nitrogen, or cholesterol levels (Gado et al., 2009). Treatments had no effect on the AST and ALT levels of nursing buffalo blood serum (Morsy et al., 2021).

A study of use biological treatment on poor quality feed ingredient discovered no significant variations in plasma serum AST and ALT levels between lambs fed biologically treated wheat straw vs control meals (El-Marakby, 2003).

Similarly, Aboul-Fotouh et al. (2017) found no significant variations in total serum AST and ALT levels among nursing goats fed the studied diets.

However, some research found that feeding animals DPL silage did not lead to a significant increase in serum glucose concentrations (Gouda et al., 2022; Hamdon et al., 2020).

Consistently, (Aboul-Fotouh et al., 2017) reported no significant differences in serum glucose levels among lactating goats receiving the tested rations.

## **3.6 Milk composition**

### **Experiment 2:**

#### **3.6.1 Impact of Experimental Diets on Milk Production and Composition**

**The effects of experimental diets on milk composition are summarized in table ten.**

There were no significant differences between sheep given experimental diets and those fed the control diet in terms of beginning body weight, final body weight, or body weight increase. This result implies that the experimental diets met the goats' nutritional requirements for both maintenance and production.

However, these findings differ from those published by (Mustafa, 2014), who showed greater weight growth in lambs when the inclusion rate of ground date seeds climbed to (30%). Similarly, it was found that adding pulverized date seeds to lamb diets increased their performance (Abdel-Azim et al., 2011). Also, lamb diets containing (30%) pulverized date seeds resulted in a decrease in overall weight growth (Abdel-Fattah et al., 2012). The differences between this study and earlier studies might be related to differences in the kind of date types utilized, the amount of date pits included in the diets, the breed of animals tested, and the physiological reactions of the animals to the dietary inclusion of date pits.

#### **3.6.2 Milk yield**

Table ten shows that dietary interventions had no significant effect on milk output.

Introducing DPL up to fifteen percent in lactating dairy sheep ration showed no adverse effect on milk yield, verifying that the energy requirements for body maintenance and production stage were supplied.

Our findings are consistent with previous research by (Atta et al., 2024), who demonstrated no significant negative effects on milk yield when goats were fed diets containing up to twenty percent date waste.

Moreover, the milk characteristics studied in our experiment algin within the usual range described in past studies. This is additional confirmation of the suitability of the feed diets used in the study.

The lack of significant change in milk yield and quality are due to the absence of negative influence in feed intake, digestibility of nutrient, and glucose levels in blood. High glucose levels in blood, as observed in previous study, indicate improved energy status in animals body, which could explain the preservation of milk supply (Rigout et al., 2003).

Furthermore, El-Zaiat et al. (2019) revealed that cows fed organic acids showed enhancement in daily milk production. The experimental treatments significantly raised milk fat levels, which are highly impacted by food composition and rumen metabolic processes. Milk fat content is a widely used measure of rumen health and fiber intake in ewes and dairy cows (Gouda et al., 2022; Zebeli et al., 2008).

**Table 10**

*Effect of feeding date palm leave on milk quality*

Group no.	Milk yield (kg)	Fat (%)	SNF (%)	Density (g/cm <sup>3</sup> )	Protein (%)	Lactose (%)	Solids (%)	Freezing point (°C)
G1	2.10	5.55	10.42	33.69	3.83	5.72	10.19	0.690
G2	2.00	6.14	10.40	34.39	3.70	5.62	8.42	0.670
G3	2.10	6.16	9.950	31.38	3.62	5.40	8.12	0.650
G4	1.90	5.80	10.54	33.96	3.87	5.78	8.70	0.700

Treatments: G1: control group; G2: chopped DPL; G3: silage DPL; G4: Alkali treated DPL  
SNF: Solids Non-Fat

### **3.7 Reproductive performance of the ewes (experiment 1)**

Feeding DPL in various ways did not alter reproductive efficiency (Table 11). The conception rate was the same in all ewes from various experimental groups. Similar patterns were reported in terms of abortions, twin percentages, and lamb births. Throughout the treatments, no dead lambs were detected.

The lack of substantial differences between the experimental dietary treatments in conception rates, lambing rates, twinning percentages, and pre-weaning lamb mortality might be attributed to appropriate feed intake, which ensured that ewes had an ideal body weight during conception.

This study's conception rate (100%) exceeded the range of (66.7% to 75%) reported for Awassi ewes mated throughout various months in Turkey (Gül & Keskin, 2010).

However, earlier study has shown that Awassi ewes had inferior reproductive performance in semi-arid parts of Near Eastern nations (Husein & Kridli, 2002; Tami et al., 2005).

Furthermore, the twinning percentages obtained in this study were within the range reported for Awassi sheep (Ahmed & Abdallah, 2012).

### **3.8 Reproductive Traits in ewes fed different forms of DPL**

The results of these features are shown in (Table12). The average period from experiment commencement to pregnancy implies that conception takes place mostly in June and July. This discovery is consistent with prior study on Awassi sheep in Jordan, as reported by (Abu-Zanat et al., 2005), who discovered that the natural mating season for Awassi rams lasts from late June to early September.

As a result, this timetable allows ewes to lamb between late November and early February.

The gestation time was not significantly different ( $P > 0.05$ ) between dietary regimens, with an average of  $150.3 \pm 3.4$  days. The gestation time for Syrian Awassi sheep was  $151 \pm 3.0$  days, whereas Zarkawi also reported a mean of 151.0 days (Zarkawi & Al-Daker, 2018). In Iran, a study on Afshari ewes also had a 151 day gestation period (Aliyari et al., 2012).

Furthermore, it was found that the kind of lambing, single or twin, had no effect on pregnancy length (Zarkawi & Al-Daker, 2018).

Lambing intervals in the experimental groups were not significantly different ( $P > 0.05$ ), with an average of  $326 \pm 17.4$  days. Awassi ewes have 338day lambing interval which it is algin with our results (Ahmed & Abdallah, 2012).

Furthermore, in Saudi Arabia, Awassi ewes had a lambing interval of  $282 \pm 4$  days ,  $245 \pm 11$  days for Najdi ewes and  $236 \pm 8$  days for Hejazi ewes (Gaili et al., 1994).

Other study demonstrated that Najdi ewes had lambing intervals of  $446 \pm 26.0$  days, and  $361 \pm 23.09$  days for Harri ewes breed (Hussein & Khattab, 2013).

## **Chapter Four**

### **Conclusions and Recommendation**

#### **4.1 Conclusions**

Date palm leaves (DPL) have demonstrated significant promise as a sustainable and economical feed resource for lactating ewes, particularly in arid and semi-arid regions where conventional forage options are limited. The current study illustrates that the inclusion of treated DPL in the diets of both ewe lambs and mature ewes did not compromise their overall performance or health status. Specifically, parameters such as weight gain, feed conversion ratio, feed digestibility, and feed costs remain unaffected by DPL supplementation, indicating that this unconventional feed source can be effectively integrated into existing nutritional strategies without adverse effects.

Furthermore, assessments of blood biochemical parameters revealed no significant alterations attributable to DPL supplementation, suggesting that the animals' metabolic functions were maintained within normal ranges. Milk production metrics, including milk yield and quality attributes (such as fat, protein, and lactose content), also showed no detrimental effects, confirming that DPL can support productive performance during lactation.

Importantly, the study found no significant differences between animals fed traditional rations and those receiving diets supplemented with various forms of DPL, underscoring the versatility and efficacy of DPL as an alternative feed ingredient. This aligns with the

broader goal of enhancing feed resource utilization, especially in regions where conventional feeds are scarce or expensive.

Given these findings, it is strongly recommended to incorporate DPL into ruminant diets as a non-conventional, yet reliable, feed source. Such an approach not only promotes sustainable livestock production by utilizing locally available agricultural by-products but also potentially reduces feed costs and enhances resilience against feed shortages. Future research could further explore optimal processing methods and inclusion rates to maximize the benefits of DPL, as well as evaluate its long-term effects on animal health and productivity.

In conclusion, integrating date palm leaves into ruminant feeding regimes offers a promising strategy to improve resource efficiency, support animal performance, and foster sustainable livestock systems in arid and semi-arid environments.

#### **4.2 Recommendation**

It is recommended to insert the (DPL) as a feed ingredient in sheep rations, especially in arid and semi-arid areas, where the traditional forages are so limited.

Before using the (DPL) in feed it is important to treat it through various methods such as chopping, drying, ensiling and alkali treated, to enhance its digestibility and its nutritional value, consequently improving its palatability and reducing its anti-nutritional factors.

It's necessary to be sure that the rations which contain (DPL) forms are balanced and achieving the sheep nutritional requirements, in addition to providing enough levels of protein, energy, vitamins and minerals which support the growth, lactation, and overall health.

Monitoring should be regulating the animal's performance through weight gain, feed conversion ratio, and overall health which will help in making necessary dietary adjustments.

According to lactation ewes, the evaluation of (DPL) on milk quality and milk yield is so important to achieving market standards and lambs' nutrition needs too.

More research is needed to ensure the feeding value of (DPL) forms. Developing and standardizing processing methods to improve the nutritional quality and safety of (DPL) can enhance its utilization. In addition, conducting feeding trials to determine optimal inclusion levels for various sheep classes will help optimize benefits and prevent potential negative effects.

To achieve the maximum benefits of (DPL) utilizing its importance to creating comprehensive awareness and building capacity programs, which should include development of user-friendly educational materials, demonstration farms, and hands-on training sessions to clarify proper processing and the correct feeding techniques.

Implementation of extra activities with farmers on their farms like field schools, workshops, field visits, lectures, focusing on extension groups, and brochures, encourage the farmers to exchange their experiences and their knowledge, so they can solve their problems, and that makes them more confident.

Also, collaboration between the government and non-government organizations is very necessary to increase the effectiveness of these activities to be sure of best applying and sharing the best practices.

Via strengthening the extension services and creation of strong skilled-farmers, lamb feeding strategies will be happening very fast and that will lead to improving sheep productivity, sustainable resource management and increasing the ability of pastoral communities to facing the obstacles in arid and semi-arid areas.

## List of Abbreviations

Abbreviation	Meaning
ADF	Acid Detergent fiber
ADG	Average Daily Gain
ADL	Acid detergent lignin
ALT-GPT	Alanine transaminase
AST-GOT	Aspartate Amino transferees
BSA	Blood sample analysis
BW	Body Weight.
BW	Body weight
Ca	Calcium
CF	Crude Fiber
CP	Crude Protein
DFM	Direct feed microbial
DM	Dry Matter
DMI	Dry Matter Intake
DMI	Dry Matter Intake
DWG	Daily Gain Weight
Donum	A unit of area equal 1000 m <sup>2</sup>
EC	Economic Side
FBW	Final Body Weight

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FCR	Feed Conversion Ratio
FI	Feed Intake
G	Group
IBW	Initial Body Weight
NAOH	Sodium hydroxide
NARC	National Agriculture Research Center
NDF	Neutral Detergent Fiber
NE	Net Energy
NIS	New Israel Shekel
NRC	National Research Council
NV	Nutrition value
P	Phosphorus
PCBS	Palestinian Central Bureau of Statistics
PFGT	Palm Fronds Grinded Treated
PL	Palm Leave
SCB	Sugarcane bagasse
SPSS	Statistical Product and Service Solution
TC	Total Cost
TDN	Total Digestible Nutrients
TFC	Total feed cost
TMR	Total mix ration
VFA	Volatile fatty acids
WG	Weight gain
ZAD	Anaerobic bacteria enzyme

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## Appendices

### Appendix A

#### Tables

**Table 11**

*Reproductive efficiency of ewes fed different forms of (DPL)*

Group	G1	G2	G3	G4
Number of ewes	5	5	5	5
Number of conceived ewes	5	5	5	5
Number of aborted ewes	1	0	0	1
Number of lambed ewes	4	5	5	4
Number of twining deliveries	3	3	4	3
Number of lambs born	7	8	9	7
Number of dead lambs	0	0	0	0

Treatments: G1: control group; G2: chopped DPL; G3: silage DPL; G4: Alkali treated DPL

**Table 12**

*Reproductive traits of ewes fed different forms of (DPL)*

	G1	G2	G3	G4
Number of ewes	5	5	5	5
Number of conceived ewes	5	5	5	5
Number of lambed ewes	4	5	5	4
Period to conception, days				
Gestation period, days	150	151	149	150
Number of services per conception	2	2.1	2.2	2

Treatments: G1: control group; G2: chopped DPL; G3: silage DPL; G4: Alkali treated DPL



جامعة النجاح الوطنية  
كلية الدراسات العليا

تأثير الأشكال المختلفة لأوراق نخيل التمر ( *ELAEIS*  
*QUINEENSIS JACQ.*) على الأداء وبعض الصفات  
الإنتاجية والتكاثرية للنعاج الهجين

إعداد

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أ.د. جمال أبو عمر

قدمت هذه الرسالة استكمالاً لمتطلبات الحصول على درجة الماجستير في الانتاج الحيواني، من كلية الدراسات  
العليا، في جامعة النجاح الوطنية، نابلس - فلسطين.

2025

## تأثير الأشكال المختلفة لأوراق نخيل التمر (*ELAEIS QUINEENSIS JACQ*)

### على الأداء وبعض الصفات الإنتاجية والتكاثرية للنعاج الهجين

إعداد  
علي عبده الشخشير  
إشراف  
أ.د. جمال أبو عمر

### الملخص

وقد تكونت هذه الدراسة من تجربتين. كانت التجربة الأولى تهدف إلى دراسة تأثير المعاملات المختلفة لسعف نخيل التمر (المفروم والسيلاج والمعالج بالقلويات) على أداء حملان النعاج المهجنة والكفاءة التناسلية. تم استخدام ما مجموعه عشرين نعجة في عمر 8 أشهر وتم تغذيتها بـ DPL بنسبة (15%) من وجباتها الغذائية. تم استبدال DPL بنسبة مماثلة من قش القمح المستخدم في عليقة الشاهد. تم تقسيم النعاج إلى أربع مجموعات تجريبية بواقع 5 نعاج في كل منها واعتبرت كل نعجة مكررة. تمت تغذية النعاج على النحو التالي: المجموعة (G1) كانت عبارة عن مجموعة شاهد تحتوي على (70%) مركز و(30%) قش قمح، بالنسبة للمجموعات التجريبية G2 إلى G4، تم إضافة سعف النخيل المعامل إلى العلائق لتحل محل نصف كمية قش القمح. تم إجراء تجربة الهضم بعد 28 يومًا من تجربة التغذية. تم تعريض النعاج للكباش وتم تسجيل معدلات الحمل والصفات الإنجابية الأخرى. قبل الحمل، تم فحص النعاج لمعرفة مؤشرات الدم وتم إجراء تجربة الهضم. أظهرت النتائج أن شكل DPL لم يكن له أي تأثير على جميع المعلمات المقاسة.

أما التجربة الثانية، فقد تم استخدام ما مجموعه 28 نعجة حلوب لفحص معاملات DPL على إنتاج الحليب وجودته ومؤشرات الدم وهضم العناصر الغذائية. حيث تم ترتيب النعاج في 4 مجموعات تجريبية بواقع 7 نعاج في كل منها واعتبرت كل نعجة مكررة. تم تغذية النعاج بأنظمة غذائية مماثلة كما في التجربة الأولى. أشارت نتائج التجربة الثانية إلى عدم وجود تأثيرات لأشكال DPL على المعلمات التي تم اختبارها. في التجربتين الأولى والثانية، تم فحص الكفاءة الاقتصادية للتغذية على الأشكال المختلفة لجريد النخيل (DPL).

يمكن أن نستنتج أن تغذية DPL في شكلها الخام أو المعالجة (معالجة بالقلويات) تعد ميزة جيدة لتقليل تكلفة العلف وكذلك حماية البيئة. ومع ذلك، ينبغي التحقيق في أفضل معالجة للمادة الخام ومستوى التضمين في الوجبات الغذائية.

**الكلمات المفتاحية:** أوراق نخيل التمر؛ أغنام هجينة؛ علف.