An-Najah National University

Faculty of Graduate Studies

EFFECTS OF USING ARTIFICIAL OR NATURAL SUCKLING ON NEWBORN ASSAF LAMBS GENERAL PERFORMANCE AND MORTALITY

By

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This Thesis was Defended Successfully on 12/1/2022 and approved by

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Dedication

To the soul of my mother, the soul of my father, to my wife, children, sisters, brothers, friends and family.

I dedicate this project

Acknowledgments

I would like to express my deepest respect and most sincere gratitude to my supervisor Prof. Jamal Abo Omar for his guidance at all stages of my work.

Thanks to my committee members:

I would like to thank all people who help me especially Eng. Moayed Salman.

Special thanks to the Farmer Mr. Rami Sawlha, who put his farm under my work.

Declaration

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

EFFECTS OF USING ARTIFICIAL OR NATURAL SUCKLING ON NEWBORN ASSAF LAMBS GENERAL PERFORMANCE AND MORTALITY

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: وائل وليد محمد

Signature:

Date: 12.1.2022

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EFFECTS OF USING ARTIFICIAL OR NATURAL SUCKLING ON NEWBORN ASSAF LAMBS GENERAL PERFORMANCE AND MORTALITY

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Abstract

Raising sheep in Palestine is not only an economic or income generation activity, but also a distinctive trait, cultural and tradition of Palestinian people. Livestock production is an integral part of Palestine's agricultural sector, which contributes up to 46% of total agricultural income.

The objective of this experiment was to study the effect of different suckling method on lamb's growth performance and mortality rate.

A total of 97 lambs were used in the study with lambing periods started from October 2020 to January 2021. Ewes' parities were 1, 2 and 3. Directly after lambing, lambs were randomly distributed according to suckling method into three groups. First group, natural suckling where lambs suckle their mothers (G1, 39 lambs), second group lambs fed completely with milk replacer (G2, 29 lambs), and the third group fed milk replacer at rate of 4 times per day (G3, 29 lambs). Single lambs of G1 were (59%) and 41% twins. Lambs from first, second and third parity were 8, 21 and 28%, respectively.

Single lambs of G2 were 62% while twin lambs were 38%. Lambs from first, second and third parties were 14, 48 and 38%, respectively. However, 69% of G3 were singles. Most of the singles (44%) and twins (21%) lambs were from the second parity. Same trend was for lambs of G2 and G3. After half an hour of lambing, lambs were isolated from their dams and placed in small wooden boxes provided by heaters and given colostrum twice daily. The natural suckling lambs (G1) were kept with their dams for free suckling until weaning at 60 days of age. However, the artificial suckling groups (G2) were isolated from dams and fed milk replacer adlibitum until weaning at 40 days of age. Lambs of the) G3)were isolated from mothers and took their milk replacer through automatic suckling machine 4 times a day half hour each time until weaning at 40 days. Results of this study showed that suckling method had no effect (P>0.05) on weaning weight at age at 40 and 60 days of single lambs. Weaning weights at 40 d were

13.7, 12.83 and 13 kg for lambs in G1, G2 and G3, respectively. The rate of mortality was affected ($P<0.05$) by suckling method. Mortality rate decreased from 18% in G1 to 7 and 3.5% in G2 and G3, respectively. Most of dead lambs were in single lambs. Liter size and suckling method had no effects ($P>0.05$) on total weight gain and average daily gain of lambs. Also, mortalities were not affected by these parameters. Sex of lambs and suckling method had no effect ($P>0.05$) on total weight gain and the average daily gain. Lambs total gain and average daily gain were not affected ($P>0.05$) by numbers of ewe's parity. Significant cost effect ($P<0.05$) were observed by feeding milk replacer to suckling lambs. Cost of milk per lamb was reduced from 120 to 40 USD. It was concluded that significant reduction will be achieved through feeding milk replacers to suckling lambs. However, these reductions are expected from the saving in milk expenses and the significant decrease of lamb's mortality rate. We recommend to use milk replacer in manage of newborn lambs.

Key words: Cross bred, Suckling method, lamb's performance, Growth rate, Mortality rate. Milk replacer.

Chapter One
Introduction

Agriculture in the Palestinian context is not merely an economic or income generating activity, but is considered as a major contributor to the protection of the land from confiscation and settlements. The agricultural sector provides currently job opportunities for 13.4% of the total labor force, and provides about 2.5 billion US $ of production value with more than 1.7 billion US$ of added value, and contributing to around 7% of the GDP and 15.2% of total exports. In particular, the livestock sector in Palestine is of major importance as it contributes to 44.5% of the total current agricultural income. The backbones of this sector are sheep and goats, dairy cattle and poultry. There are 890,000 sheep and goat and 65,000 cattle of which 34,000 are cow the West Bank and Gaza Strip (Agricultural Statistics (2018/2019), D.G Planning and Policies, MoA).

Livestock is raised as a secondary activity in many places in Palestine to provide supplementary income to rural households. Therefore, the small ruminant's sector is an important source of income for many Palestinian families while they produce important products for local consumers and provide a source of self-employment. Furthermore, it is important to notice that the women from the household contribute greatly to this sector in terms of labor and skills. About 26% of total sheep in Palestine are raised in Hebron (230,000 heads), 12% in Jenin (105,000) and 11% in Nablus (100,000). Hebron also hosts the largest number of goats at 28%, followed by Nablus at 13% and Jenin at 12% (Agricultural Statistics (2018/2019), D.G Planning and Policies, MoA).

Around 90% of the goats are of local breed, and 3% are Shame goats. Sheep and goat production is practiced by 20,000 households in Palestine. Livestock of small herders account for some 80-85% of total animal numbers. Data shows that around 15% of goat holdings are with less than 5 goats and 26% of sheep holdings are with less than 10 sheep. (Palestinian Ministry of Agriculture (MoA) 2015 – Livestock Sector Strategy 2015-2019).

Livestock in Palestine is not only an economic or income generation activity, but also a distinctive trait, cultural and tradition of Palestinian people. In addition, livestock is of particular importance for Palestinians as it embodies their perseverance, confrontation

and adherence to the land under the threat of confiscation and settlement. Livestock production is an integral part of Palestine's Agricultural sector, and is of economic and social importance both at the household and national levels. It has been an important form of traditional Palestinian livelihood for centuries. (Livestock Sector Strategy 2015-2019).

Small ruminant production has the potential to address the global challenge of greatly increased food production in impoverished rural areas in a manner that is socioeconomically sustainable (Chinnaiyan,2019).

Livestock in Palestine is not only an economic or income generation activity, but also a distinctive trait, cultural and tradition of Palestinian people. Livestock production is an integral part of Palestine's agricultural sector which contributes up to 46% of total agricultural income (FAO. 2018).

Livestock has economic and social importance both at the household and national levels. Livestock in Palestine is dominated by cattle, poultry, sheep, goats, beekeeping and fishes. It provides the main source of income and food security for thousands of Palestinian households in rural areas and Bedouin communities in the West Bank and Gaza Strip (Ministry of Agriculture State of Palestine. Livestock Sector Strategy 2015-2019).

While sheep production is of great economic and social importance in most rural districts, it faces several obstacles such as high feed prices, marketing, and lack of efficient management skills, as well, low breed productivity. Besides the previous obstacles high newborn mortality rate become one of the main reasons for insufficient farm profitability and may be the main causes for small ruminant farming loses. (MoA, 2013).

Meanwhile low breed productivity is the main reason for insufficient livestock farming profit. In order to improve the livestock production particularly small ruminants, the government of Palestine has given importance to the development of its livestock sector as part of its agricultural strategic policies. The implementation of reproductive technologies such as artificial insemination (AI) is highly effective approach for increasing livestock productivity.

Ruminants (cows, sheep and goats) in Palestine are raised under an intensive or semi-intensive breeding systems. Intensive production entails confining livestock in narrow spaces, where they are fed, watered and milked without being released to graze. This system is adopted mainly by cow breeders and to a lesser degree by sheep and goat breeders. (MOA, 2015 - 2019)

On the other hand, semi-intensive production (traditional) allows livestock to graze, while providing supplementary nutritional feed at the same time. Intensive production requires a higher capital investment in infrastructure and administrative systems than the semi-intensive production system. In addition, intensive production requires high technical experience and knowledge in farm management, which is an aspect absent in many farmers, especially the younger ones. (MOA, 2015 - 2019).

Palestinian sheep farming is characterized by the breeding of fat tail local Awassi (AW), Assaf (AF), and AW X AF crosses sheep grazed on semi-intensive pastures in late winter and spring and fed indoors with barley, wheat bran, and hay most of the year. All these breeds are characterized by great genetic diversity (large and small tails an horned/ polled, white/color), they are of moderate size compared to other sheep breeds with ewes weighing 50 kg for AW to 70 kg for AF, rams 80 - 120 kg, prolificacy between 1.15 – 1.6 lamb born per ewe lambing, milk production from 110 to 300 litter per season (120 days), and moderate to hardy adapted to the harsh climate condition of West Bank. (MoA, 2014).

The implementation of reproductive technologies such as artificial insemination (AI) is highly effective approach for increasing livestock productivity. The use of these techniques results in newborns that must be taken special care. The population of sheep and goats is fluctuating from a year to another. The reason behind that is the high incidence of mortalities among the newborns. It was estimated that newborns mortalities per year was 150 thousand heads which is equal to 18% of the newborns (Ministry of agriculture, 2013; PCLI, 2019). In order to assure stability of small ruminants' population and wellbeing it is important to improve the quality of the newborns through good management practices. Good care during nursing and adoption of new techniques in feeding the newborns should have a positive impact on the health conditions of the newborns and reducing mortality rate in local sheep and goats' herds.

We hypothesize that using of artificial suckling (utilizing milk replacer) will decreasing lambs newborn mortality rate less than 18%.

One of the most obstacles of small ruminant farming in Palestine is new borne mortality rate, it causes high loses and affect profitability, according to study conducted by MoA (2013) new borne mortality rate ranged from 9% to 24%, the normal rate should not exceed 5%. The main reason for this high rate is bad management. However, it's expected to decrease mortality rate by at least 10% in targeting farms.

The objective of this study was to investigate the effects of suckling method on lamb's performance lamb's mortality rate.

Chapter Two

Literature Review

One of the most obstacles of small ruminant farming in Palestine is the new borne mortality rate that causes high loses and affect profitability. According to study conducted by the ministry of agriculture, MOA, (2013), new borne mortality rate ranged from 9% to 24%, knowing that the normal rate should not be exceed 5%. The main reason for this high mortality rate is the bad management. However, applying good management practices is expected to decrease mortality rate by at least 10% It was estimated that newborns mortalities per year was 150 thousand heads which is equal to 18% of the newborns (Ministry of agriculture, 2013; PCLI, 2019).

Assaf sheep is considered of high genetic potential as dairy and prolific breed. In order to sustain high production, good nutrition and management is very important (Devendra, 1987).

To decrease new borne mortality rate, it is recommended to use milk replacer which has other sources of protein rather than the natural milk casein, (ministry of agriculture, 2002). The main sources of milk replacer protein are whey, butter milk and vegetable protein from legumes such as soybean (Kolar and Wagner, 1991; Turkur *et, al.,* 1995; Terosky *et, al.,* 1997; Lammers *et, al*., 1998). However, Jenkins *et, al.,* (1980) reported that protein from legumes is of lower digestibility compared to milk protein.

Sezen and Soner (2013) found that average daily gain for lambs with natural suckling less than lambs with milk replacer, while weaning weight for natural suckling lambs and milk replacer lambs at 42 days age were 12.64 kg and 14.15 kg respectively. Also, milk replacer decreases lamb's mortality rate.

Gootwine *et, al.* (2008) reported that the average birth weight for Afec Assaf was 4.5 kg, and average weaning weight was 14.7 kg on 35 days, and the average daily gain was 294 g. for the Afec-Assaf and 1/2 Suffolk, the system was used the artificial suckling on the milk replacer. Genetic analysis suggested no significant ($P > 0.05$) differences between the Suffolk and Afec-Assaf in birth weight or in post weaning average daily gain.

A trial conducted to evaluate the influence of non-genetic factors on lambs' growth during artificial suckling using milk replacer, three groups were introduced to artificial suckling, and the results on weaning weight did not have a significant difference, however, profitability increased from selling fresh milk. (Makovický *et, al.,* 2019).

It was found that lamb sex has no significant effect (P>0.05) on birth weight, weaning weight, and average daily gain from lambing to weaning, while litter size significantly (P<0.05) increases in single borne lambs than twins (Miguel *et, al,* 2016).

Vatankhah and Talebi (2009) studied the effect of age of dam (Parity), type of birth (litter size), and six of Lamb on lamb's mortality rate and reported that age of dam and lamb sex has no effect on lamb mortality rate, while type of birth affect mortality rate, lamb mortality rate was higher in twins).

According to Assan and Makuza (2005) sex had significant effects (P<0.001) on weaning weight and the average males' weights were heavier than females (P<0.001) at weaning in the mutton merino, Dropper. Also, single lambs were significantly heavier at weaning compared to twins

It was found sex of lamb, type of birth, age of dam and ewe weight were significant sources of variation for lamb weights and daily gains on Bharat Merino (Dixit *et, al,* 2001,).

The effects age of ewes, sex and birth types of lambs on weaning weight and average daily gain were studied by (Ayhan, *et, al,* 2009,) they found significant effect of these factors on studied traits.

Some studies showed the influence of parity on lamb mortality, birth weight, weaning weight, milk yield on different breeds in temperate countries (Mavrogenis 1996; *et,al,* Fuente *et, al,* 1997; Franci et al 1999; Ploumi and Emmanouilidis 1999; Sevi *et, al,*2000).

Milk yield interaction with liter size had highly significant effect on lamb growth rate (P < 0.001). Single lambs had higher daily growth rate than multiple born lambs (Mohapatra Arpita, *et, al,* 2020), (Peeters *et, al,* 1992) found that twin lambs grew slower than singles.

The effect of age of dam, sex of lams, and litter size showed significant effect on lamb daily gain, the highest daily gains from birth to 100 days of age were recorded in males, single lambs, and from 4-years-old ewes. Also, the body weight at birth showed a positive and highly significant ($P \leq 0.01$) effect on the majority of growth traits (Kuchtík and Dobeš, 2006).

The effect of litter size, dams' age and gender on growth rate was studied. Male lambs were higher than females in birth weight, weaning weight, and average daily gain. Also, young dams produced lower lambs at birth than older dams (Jesús *et, al*, 2015).

Sex of lamb and type of birth were effect significantly ($P<0.05$) lambs birth weight and growth rate from lambing to weaning, the overall least-square means for body weights were 2.18 kg, 10.58 kg 98.68 g for birth, weaning and growth rate respectively (Al-Bial and Singh,2012)

Significant influence of sex ($P< 0.05$) on the average daily gain, while litter size affects the average daily gain *(*$P<0.01$) on the average daily gain on the first week of putting lambs in the pens. At the end of milking season, the average daily gain was the same for male lambs (Makovický, *et, al*, 2019).

Bulent Ekiz, *el, at*, 2012) found that unwanted lambs had higher growth rate while twin lambs had lower growth rate than single lambs. It was found that males and single have more growth rate than females and twin lambs.

At two-week intervals, the average daily gain (ADG) and live weights body weight (BW) were measured. At 2 and 4 weeks of age, ewe raised (ER) lambs were heavier (P0.05) than artificially reared (AR) lambs, however there were no differences in body weight between AR and ER lambs at 6 weeks of age. At 2 weeks of age, litter size had a significant impact on birth weight (P0.01) and body weight (P0.05). AR lambs had an 85 percent survival rate until they were 6 weeks old, compared to 75 percent for ER lambs. These findings demonstrate that Awassi lambs can be effectively fed on calf milk replacer at a cheaper cost than ewes (Emsen, *et, al*, 2004).

Before weaning, milk supply is one of the factors that can influence lamb body weight (BW) and immunological state. The purpose of this study was to see how different milk sources affected lambs' BW and immune status during the milk feeding and weaning

period (natural rearing method, NR group vs. artificial rearing method using a commercial milk replacer, MR group vs. artificial rearing method using whole powdered cow milk, CM group). In this experiment, 60 lambs were divided equally by sex and then randomly divided into three groups (NR, MR and CM).

The plasma was tested for immunoglobulin content (IgG and IgM), chitotriosidase activity, complement system activity, total complement activity (TCA), and alternate complement activity (ACA). The immunoglobulin concentrations (IgG and IgM), chitotriosidase activity, complement system activity, total complement activity (TCA), and alternative complement activity were all measured in the plasma (ACA). The results showed that at 3 and 5 days after birth, lambs reared with NR had higher BW, IgG, IgM, TCA, and ACA than animals reared with MR or CM (P0.05). During weaning, however, these discrepancies vanished. Animals in the MR and CM groups had greater BW than NR lambs at the end of weaning (15.28, 16.89, and 17.66 kg in the NR, MR, and CM groups, respectively, P0.05). Furthermore, IgM concentrations were greater in the MR and CM groups than in the NR group (1.05, 1.90, and 1.60 mg/mL in NR, MR, and CM, respectively, P0.05). If the proposed alternative milk feeding source (whole powdered cow milk for human use) is chosen for feeding lambs reared under an artificial raising system, the current findings may improve sheep farm management while lowering artificial rearing system expenses. As a result, these findings can be used to increase sheep breeders' economic benefits. (Hernandez, *et, al*, 2015)

Data gathered at the US Meat Animal Research Center from 1980 to 1985 for paternal and maternal breeds lambing yearly and maternal breeds lambing at 8-month intervals were used to investigate the sources of individual plus maternal effects on lamb mortality. There were 16,881 lambs born according to the records. Finn sheep 0, Dorset (D), Rambouillet (R), Suffolk (S), Tar ghee 0, Composite 1 (C1 = F/2, D/4, R/4), Composite 2 (C2 = F/2, S/4, T/4), and Composite 3 (C3 = Columbid2, S/4, Hampshire/4), and Composite 3 (C3 = Columbid2, S/4, Hampshire/4). Perinatal, postnatal, and total mortality up to 60 days of age, as well as postnatal respiratory, digestive, hunger, injury, and other or unborn causes of death, were also examined. Breed, year, sire within breed-year, sex, linear and quadratic season, and age of dam covariates (Model l), plus litter size (Model 2), plus birth weight (Model 3), and significant two-way interactions were included in the least squares analyses. The age of

the dam, litter size, and birth weight all exhibited significant, often quadratic, effects that varied by breed. Models 1, 2, and 3 reduced variations in perinatal mortality by 8, 10, and 16 percent, respectively, in postnatal mortality by 7, 8, and 12 percent, and total mortality by 9, 11, and 20 percent. In Model 1, prenatal breed means ranged from 3.5 to 16.2 percent, whereas perinatal breed means ranged from 7.2 to 21.1 percent. for Total mortality ranges from 16.7% to 32.8 percent postnatally. Postnatal death was primarily caused by respiratory and nutritional disorders. C1 had a 9 percent heterosis for lamb survival in composites, while C2 had an 18 percent heterosis. Males had a 1 to 5% greater mortality rate than females. The more prolific breeds were superior in lamb viability and had lower ideal birth weights at the same litter size and ratio of birth weight to mature size reported that mortality rate for male lambs was higher than females, and viability of lambs increased by prolificacy with lower birth weight. (Gama and colleagues, 1991).

The goal of this study was to see how artificial rearing affected lambs' growth and metabolism, as determined by some critical blood chemical characteristics. A total of 20 Chios lambs were employed in this experiment. Two groups of newborn twin and triplet lambs were formed. The artificially reared (AR) group consisted of twins or triplets' first-born lambs. The ewe-reared (ER) group consisted of the remaining lambs. During the first 24 hours after birth, as well as weeks 1, 2, and 3, blood samples were obtained from lambs in both groups. The impact of the raising method on plasma total protein, albumin, globulin, glucose, urea, total lipids, survival rate, body weight, and average daily growth (ADG) was investigated. Rearing strategies had a substantial impact on body weight and ADG (P 0.001). The ER group's plasma total protein and globulin concentrations were considerably higher than the AR group's at 18 and 24 hours, as well as weeks 1 and 2. The ER group had significantly greater plasma urea concentrations at 18 and 24 hours, as well as plasma total lipid concentrations at 24 hours and at week one, than the AR group. Finally, our findings showed that artificially rearing lambs using calf milk replacer reduced survival and slowed growth rates. (kemal, *et, al,*2006).

The effects of three weaning strategies on milk supply and lamb growth were studied using East Friesian crossbred ewes (n = 99) and their lambs (n = 232). For the first 28 3 days of nursing, a ewe and her lambs were randomly assigned to one of three treatments prior to parturition: 1) ewes weaned from their lambs at 24 hours postpartum, machine milked twice daily, and their lambs raised artificially (DY1); or 2) ewes separated from

their lambs for 15 hours in the evening, machine milked once daily in the morning, and their lambs allowed to suckle for 9 hours during the day (MIX); or 3) ewes not machine milked and exclusively suckled by their lambs (MIX) (DY30). Lambs were weaned from MIX and DY30 ewes after the treatment period, and machine milking was performed twice daily on all three groups. Lambs were weighed at weaning or at 28 days and at around 120 days of age, and daily commercial milk output and milk composition were recorded weekly or twice monthly. Lactation length was 183 5 days on average (suckling + milking period) and was similar among weaning techniques. Milk output, milk fat and protein percentages, and somatic cell count differences between weaning techniques were highly significant prior to and around weaning, but were no longer significant by 6 weeks of lactation. DY1 and MIX ewes produced the most total commercial milk (261 and 236 kg/ewe, respectively), whereas DY30 ewes produced the least (172 10 kg/ewe). However, after 120 days, DY30 lambs tended to be the heaviest, MIX lambs intermediate, and DY1 lambs lightest (47.3 1.6, 45.9 1.8, and 43.7 1.2 kg, respectively). The MIX system had the highest overall financial returns for milk and lamb sales due to an increase in marketable milk during the first 30 days of lactation compared to the DY30 system, as well as 1660 acceptable 120-day lamb weights without artificial rearing costs compared to the DY1 method. During early lactation, a mixed system of suckling and milking appears to be an effective management strategy for dairy sheep. (McKusick, *et*, *al*, 2001)

The daily gain in the late feeding phase (15-30 days) was larger in artificially reared animals than in those fed by their mothers (310 versus 245 g/day, p 0.001). The findings show that lambs raised artificially have a decreased rumen functioning, allowing them to be slaughtered at higher weights without sacrificing meat quality. (Fuente, *et, al*.1997).

During early lactation, lamb development and ewe milk production were strongly associated. There was no link between milk components and growth. (.Wohlt,*et,al,*1980).

The effects of two milk replacer (MR) formulations on lamb performance, morbidity, mortality, antibiotic use, and health-related expenses of artificial lamb rearing were studied in this study. The mortality rate of MR1 and MR2 lambs was similar (8 vs. 10%,

P = 0.79). Overall, MR1 had a higher average dally gain (ADG) than MR2 (mean SE: 296 17.6 vs. 242 17.7 g/d, P = 0.02). reflecting their lower ADG of 53 g/d When MR1 lambs were compared to MR2 lambs, there was a considerably lower frequency of animal health concerns and associated antibiotic use (ranging from 1.5 to 13 times). As a result, MR2 had higher expenditures related with animal health interventions than MR1. (Mccoard,*et,al,*2020).

Poll Dorset ewes from a commercial sheep milking operation were utilized in two tests to see how limiting lamb access to ewes affected milk yield and content, as well as lamb growth rates. These findings show that Poll Dorset lambs can be successfully reared by restricting their access to their mothers, with very minor reductions in the ewe's total dairy milk output. (Knight, *et, al,* 1992)

Lamb meat from milk substitute-fed lambs was more valued and had a longer shelf life than lamb meat from natural-milk-fed lambs. Consumers judged the appearance of the meat based on the color of the overall surface of the leg cut. The most crucial variables utilized to assess the appearance of meat were lightness and angle of colour. (Guillermo, *et, al,* 2017)

Direct suckling lambs and lambs given buffalo milk (175 and 151, and 14.5 and 12.5, respectively) had similar (P > 0.05) least square means of ADG (g/day) and overall weight gain (kg), but were greater (P 0.05) than those given cow milk (118 and 10.4) or milk replacer (94 and 7.7). Feeding cost (per kg of live weight) was highest in milk replacer-fed lambs and lowest in the other three groups (P > 0.05). The cost of raising lambs on buffalo milk was generally cheaper than that of lambs raised on cow milk. In the lack of ewe's milk, it appears that growing Kajli lambs (one of Pakistan's most attractive sheep breeds) on buffalo-milk during the pre-weaning period is a superior option. (Musharraf, *et, al,* 2014).

Lamb production does not have to be labor-intensive or associated with a high rate of lamb death at a loss. According to the findings of the Virginia Tech study, the actual time required to adjust 50 or less lambs milk replacer, milk replacer mixing, cleaning equipment, and general lamb health monitoring is about 1.5 hours per day. Industrially bred lambs may be effectively weaned to dry diet for around US$25 per head, with a retail price of $30 for a 25-pound bag of milk replacer. Raising twin lambs on a sheep

of the same weaning weight as industrially reared lambs would cost $25 to $30 per person, based on average Virginia herd production expenditures. As a result, lambs can be effectively reared on milk replacer at a cost comparable to raising a sheep using the techniques discussed in this post. Artificial breeding on a self-feeding system was thus regarded a solution to save more lambs and boost profitability through a higher proportion of marketed lambs by the sheep breeder with no pedigree and a high number of multiple births. (Steven H, *et, al*,2009)

Chapter Three
Materials and Methods

3.1 The study site:

The study was carried out at private Assaf sheep farm at Al Nasaria village - Nablus district, North of West Bank. Figure (1). The number of sheep, mothers 300, and newborns 430 males and females, was a natural method newborn in the farm, Newborns stay with their mothers.

The farm management system that has been applied was the semi- intensive where sheep grazed all the day in spring and early summer and kept indoor in autumn and winter. The sheep herd is characterized by high milk production, high twining rate, and high lamb growth rate. Also, estrus synchronization is practiced routinely to minimize lambing interval.

Nutrition The farmer provides concentrated and hay feed, the sheep go to the pastures

the mortality rate in lambs is high, Manual milking method for sheep and milk is marketed cheese.

Figure (1)

Geographic location of farm sheep In Palestine.

3.2 Farm selection:

The Demo targeted tow farmers located in Nablus (North of West Bank).

A selection questioner to choose the farm was

implemented, it focused following points:

- Sheep Breed (Awassi, Assaf, Crossbred) – pure breed got higher points.
- Percent of Lamb mortality rate – we choose the farmer that has more mortality rates.
- Flock size- from 250-300 is the best.
- Farm should have suitable place for the demo.
- The advantage was for the farm who sells Lambs at fattening not at weaning.
- And farmer should have a good income so he can apply the demo in his farm.

The main goal of the demonstrations is to raising the performance level of lambs and decrease the newborn mortality rate and the following sub objectives:

- Compare the percent of newborn mortality between artificial and natural suckling.
- Study the effect of artificial suckling on weaning age, weaning weight and
- average daily gain from lambing to weaning.
- And calculate the economic replacement of powder milk in suckling.

distributed equipment:

The following equipment has been provided, from the student. Figure 2 (A):

- Natural Colostrum ewes with newborn. figure 2 (B).
- Ewes with new born until 60-day age figure 2 (C).

The student and the university funded these materials for the purpose of demonstration:

1. A light bulb with a reflector and 100 watts. heating
2. Plastic bowl 60 * 80 cm.
3. Small plastic feeding.
4. Two automatic feeding machine.
5. Plastic tray 120 * 120 * 90 cm.
6. Powdered milk.
7. Water bowl.
8. Feeding container.
9. Carpentry bags.

Figure 2 (A)

Equipment has been provided, from the student.

3.3 Management of ewes and lambs:

Total of 97 lambs from 78 ewes were distributed to three groups and used in the study (Table 1). The lambing period started from October 2020 to January 2021.

Directly after lambing, lambs were randomly distributed according to suckling method into three groups. First group, natural suckling where lambs suckle their mothers G1, second group lambs fed completely with milk replacer G2, and the third group fed milk replacer at rate of 4 times per day G3. (Table 1).

Table 1

Number of ewes and lambs used in the study.

Group	Total ewes	Total lambs
G1	30	39
G2	22	29
G3	26	29

[1] **G1=** group 1**; G2=** group 2**; G3=** group 3**.**

Directly after lambing, lambs of G2 and G3 were isolated from their dams and placed in small wooden boxes provided by heaters and given colostrum three times daily until 3 days. While the natural suckling lambs G1were kept with their dams for free suckling until weaning at 60 days of age. However, the artificial suckling group G2 was isolated from dams and fed milk replacer adlibitum until weaning at 40 days of age. Lambs of the G3 were isolated from mothers and took their Lambs were weighted on a digital scale at birth, 40 days, and 60 days. Knowing that the percent of milk powder to water was 165 gm of milk to one litter of water.

Daily follow-up to the three groups, from monitoring the amount of colostrum, changing the wood shavings from the floor on a daily basis, controlling the heating system to the lambs, and transferring the first and second group of small boxes to large boxes and then to the barns according to the specified time schedule, adding concentrated feed protein 18% to the three groups after two weeks of birth and recording the amount of feed consumption.

The weight of the lambs in the three groups is taken every three days until the daily weight gain is calculated for each lamb.

Milk consumption was calculated on a daily basis to the three groups in order to calculate production costs.

Natural Suckling Management System:

- First day after birth.
- Natural Colostrum ewes with newborn.
- Ewes with new born until 60-day age.

Figure 2 (B)

Natural Colostrum period ewe with newborn.

Figure 2 (C)

Ewes with new born until 60-day age,

Artificial Suckling Management System:

- Fist days after birth.
- Artificial Suckling Colostrum period figure 3 (A).
- Small groups of new born animals' figure 3 (B).
- Artificial suckling management. Figure 3 (C).
- Artificial suckling Until 40 days of Age. Figure 3 (D).

Figure 3 (A)

Artificial Suckling Colostrum period

Figure 3 (B)

Small groups of new born animals in box.

Figure 3 (C)

Artificial suckling management.

Figure 3 (D)

Artificial suckling Until 40 days of Age.

Characteristics of lambs suckling naturally and artificially are in Table 2. Ewes were of parity 1, 2, and 3, and most of it with single deliveries. Percent of single lambs from G1, G2, and G3, were 59%, 62%, and 69% respectively. Numbers of lambs either single or twins that come from parity 2 were more than lambs that come from parity 1 and parity 3 as shown in table 2.

Table 2

Characteristics of lambs suckling naturally and artificially.

	G1 [1]	**%**	**G2**	**%**	**G3**	**%**
No. of lambs	39	100	29	100	29	100
S [2]	23	59	18	62	20	69
T	16	41	11	38	9	31
P1	3	8	4	14	3	10
P2	25	21	14	48	21	72
P3	11	28	11	38	5	17
SP1	1	3	2	7	1	3
SP2	17	44	9	31	16	55
SP3	5	13	7	24	3	10
TP1	2	5	2	7	2	7
TP2	8	21	5	17	5	17
TP3	6	15	4	14	2	7

[1] **G1**= group 1**; G2**= group 2**; G3**= group 3**.**

[2] **S**= Singles; T= **Twins;** P1= parity 1**;** P2= parity 2**;** P3= parity 3**;** SP1= single parity 1**;** SP2= single parity 2**;** SP3= single parity 3**;** TP1= twin parity 1**;** TP2= twin parity 2**;** TP3= twin parity 3**.**

3.4 Milk Chemical analysis:

Milk and milk replacer samples were taken weekly then stored for later analysis. Samples were analyzed for chemical composition (total solids, fat, protein, solids non-fat, lactose, Ash) in table 3.

Table 3

Fresh and milk replacer chemical composition.

Chemical composition%	Fresh Milk	Milk replacer (powder)
Total solids	0.84	93
Milk fat	6.11	20
Protein	3.75	23
Solids not fat	10.24	73
Lactose	5.63	38
Ash	0.95	9

3.5 Cost analysis:

3.5.1 Feasibility study.

Before the experiment was applied, the farm's only income was from surviving lambs until Weaning, the seasonal milk production was calculated and the mortality rate was calculated, the annual income was estimated, Annual input costs after the implementation of the neonatal management system, powdered milk is the main cost. Annual income after applying the management system Weaned lambs contribute to the main income, then the milk produced until weaning and then the animal's body weight at weaning, shows net income from weaned animals, milk produced and weaning weight, the highest net income was recorded on a sheep farm.

Costs of nursing were calculated for the comparison between the three nursing systems, the death of lambs and operational expenses were calculated.

Number of lambs, milk consumption, mortality rate from lambing to weaning, TMY60, and by group are Lamb need 9.68-12.4 kg powdered milk or 80 kg fresh milk from lambing to weaning. Mortality rate was 0.002-0.06 in the groups that reared in

powdered milk, and 0.19 in the group reared in fresh mother milk. Price of kg Natural Milk = 1.56 US

Price of Kg Powdered milk =4.37 USD

Price of weaned Lamb = 312.5 USD

Lambs Lost, milk Consumed, Natural milk produced, Fresh Milk Value (USD), Weaned Lambs Value (USD), and Powdered Milk Value USD) are in this thesis.

It was found that Net Gain (USD) 7073.7 by using milk replacer from 72 ewes divided into 3 groups was 7073.7

Artificial suckling reduce mortality from 19% to 5%. Also, the cost of weaned lamb in artificial and natural suckling was, 48.4 USD and 108 respectively. Which means that we can save 59.4 USD from milk for each lamb when we replace natural suckling by artificial suckling, and reduce lamb mortality rate by 14%.

3.6 Data collected and analysis:

The initial and final (weaning at 60 days) weights of G1 lambs were recorded. However, the final (weaning) of G2 and G3 lambs was recorded at 40 days. Growth rate was calculated by the following formula:

Growth rate = weaning weight-birth weight/ weaning age.

Mortality rate (MR): Lambs mortality in the three groups from lambing to weaning was recorded.

Total milk yield from lambing to 60 days of lactation (TMY60), was calculated by using the Fleischmann method (Ruiz et al., 2000):

$$TMY = y1t1 + \sum ((yi + yi+1)/2)\ (ti+1 - ti))$$

Where y1 is the daily milk yield at first milk recording; t1 is the interval (in days) between lambing and first recording; *Yi* is the daily milk yield of the milk recording, and (*ti*+1 - *ti*) is the time interval (in days) between record *i* and record (i+1), (i=1, …… k).

Three fresh milk samples were collected from group1 during a period of 60 days. Samples were analyzed for chemical composition (total solids -TS, fat, protein, solids

non-fat -SNF & Ash) as well as pH and acidity which determined as given by Ling (1963) and lactose content as described by Barnett and Abd El-Tawab (1957).

The consumption of milk replacer was estimated by calculating the total milk consumed at the end of the suckling period for each group divided by total number of lambs (Table 12).

3.7 Statistical analysis:

All traits were analyzed by univariate general linear model (GLM procedure of SPSS) with explanatory variables as fixed effect. And the following Model:

$$Yijklm= \mu + Gi + DWj + LSk + Sexl + PRm + eijklm.$$

Where Yijklm refers to the observation; μ, the population mean; Gi, the group effect (i=G1, G2, G3); DWj the effect of dam weight (j= 50-60, 60-70); LSk the effect of litter size (k=1,2); Sexl the effect of lamb sex (l= M, F); PRm the effect of ewe parity (m= 1,2,3), Yijklm the random error normally distributed with a mean 0 and variance σ^2e.

Fixed effects for traits and number of records used in the model are in tables: (1). Means of variables analyzed were compared using estimated statistical mean differences (Bonferroni option of SPSS), Statistical differences were considered significant at $p < 0.05$.

Milk contents (fat, solid not fat, lactose, protein, and total solid) were used as a covariate when measured the p value for these factors on lambs' growth rate from lambing to weaning and lamb's mortality.

Chapter Four
Results and Discussion

4.1 Performance of lambs under different suckling methods:

Performance of lambs under different suckling methods are in table 4 and figure 4. The results of the study showed that the suckling method had no effect on weaning weight at age at 40 and 60 days of single lambs (Table 4). Weaning weights at 40 d were 13.7, 12.83 and 13 kg for lambs in G1, G2 and G3, respectively. Similar trends were observed in twin lambs where average weaning weights were 18.42, 18.28 and 19.29 kg for lambs of G1, G2 and G3, respectively. Sezen and Soner (2013) found that average daily gain for lambs with natural suckling less than lambs with milk replacer, while weaning weight for natural suckling lambs and milk replacer lambs at 42 days age were 12.64 kg and 14.15 kg respectively.

Gootwine *et, al*., (2008) reported that the average birth weight for Afec Assaf was 4.5 kg and the average weaning weight was 14.7 kg on 35 days, and the average daily gain was 294 g for the artificial suckling on the milk replacer.

Lambs under different suckling methods had similar gain and average daily gain (Table 5). Similar findings were reported in previous research (Makovický *et al.,* 2019) where in a trial that was conducted to evaluate the influence of non-genetic factors on lambs' growth during artificial suckling using milk replacer, three groups were introduced to artificial suckling, and the results on weaning weight did not have a significant difference, however, profitability increased from selling fresh milk. (Makovický *et, al,* 2019).

Table 4

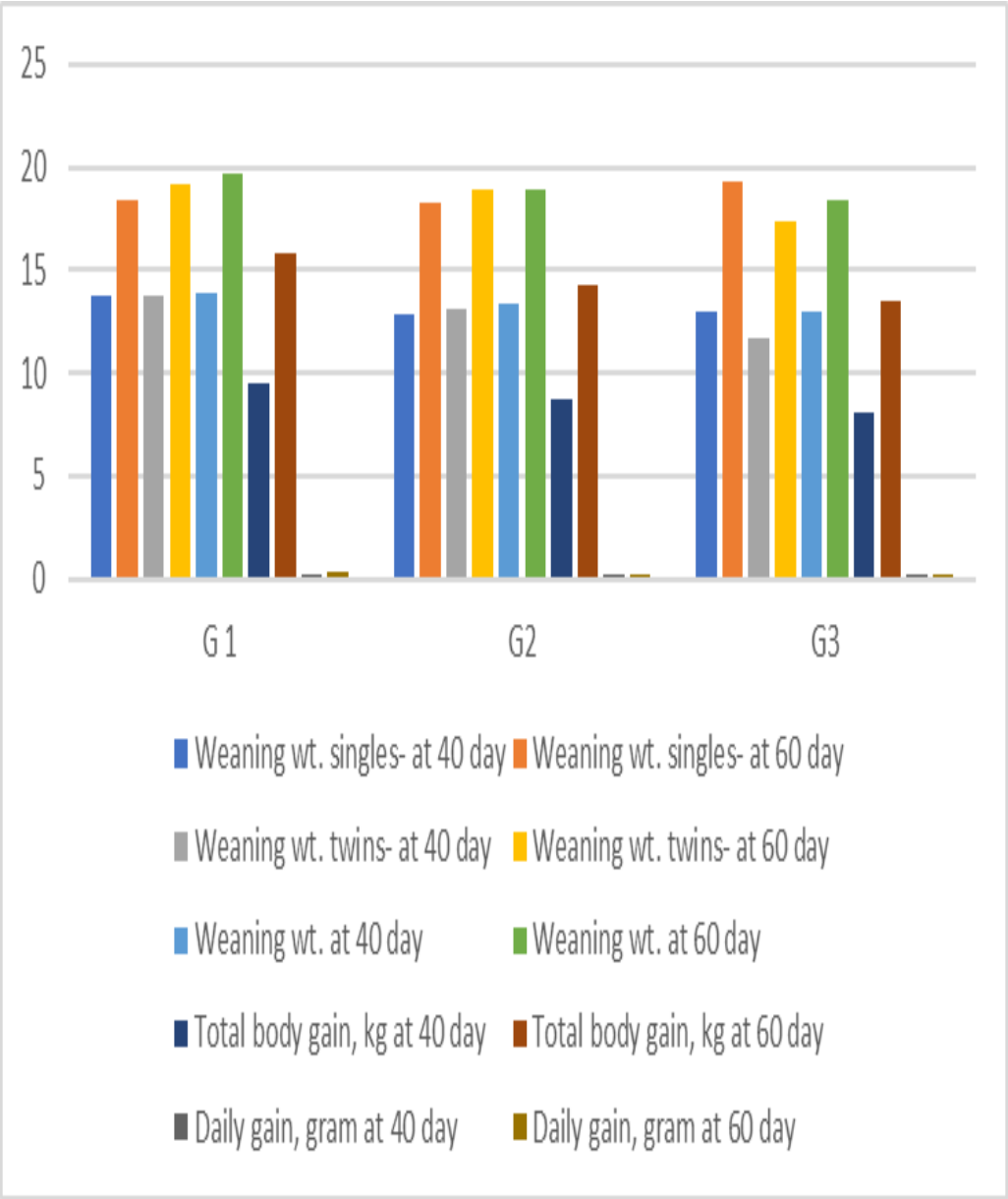
Performance of lambs under different suckling methods, kg

Parameter	**G 1**	**G2**	**G3**	**P value**
Weaning wt. singles- at 40 days	13.76	12.83	13.0	> 0.05
Weaning wt. singles- at 60 days	18.42	18.28	19.29	> 0.05
Weaning wt. twins- at 40 days	13.77	13.17	11.74	> 0.05
Weaning wt. twins- at 60 days	19.16	18.89	17.41	> 0.05
Weaning wt. at 40 days	13.88	13.35	12.98	> 0.05
Weaning wt. at 60 days	19.75	18.9	18.37	> 0.05
Total body gain, kg at 40 days	9.55	8.77	8.06	> 0.05
Total body gain, kg at 60 days	15.85	14.32	13.45	> 0.05
Daily gain, gram at 40 days	0.239	0.219	0.201	> 0.05
Daily gain, gram at 60 days	0.264	0.239	0.224	> 0.05

[1] **G1=** group 1**; G2=** group 2**; G3=** group 3**.**

Figure (4)

Performance of lambs under different suckling methods, kg



4.2 Mortality of lambs under different suckling methods:

Summary of the influence (P values) of the fixed-effect factors lambs growth rate from lambing to weaning (GRL-W) Mortality rate (MR), by milk quality analysis are No significant effect (P>0.05) of Fat, Solid Not Fat, Lactose, Protein, and, Total Solid on GR L-W or MR. only P value percent of milk fat was 0.06 for MR was relatively not too much far from 0.05. So, more studies are needed to evaluate the effect of milk composition on lamb's mortality rate.

Mortality of lambs under different suckling methods are in Table 5 and figure 5. One of the most obstacles of small ruminant farming in Palestine is the new borne mortality rate that causes high loses and affect profitability. According to study conducted by the ministry of agriculture, MOA, (2013), new borne mortality rate ranged from 9% to 24%, knowing that the normal rate should not be exceed 5%. The main reason for this high mortality rate is the bad management.

In this experiment the rate of mortality was affected by suckling method. Mortality rate decreased from 18% in G1 to 7 and 3.5% in G2 and G3, respectively (Table 5). Most of dead lambs were in single lambs.

Table 5

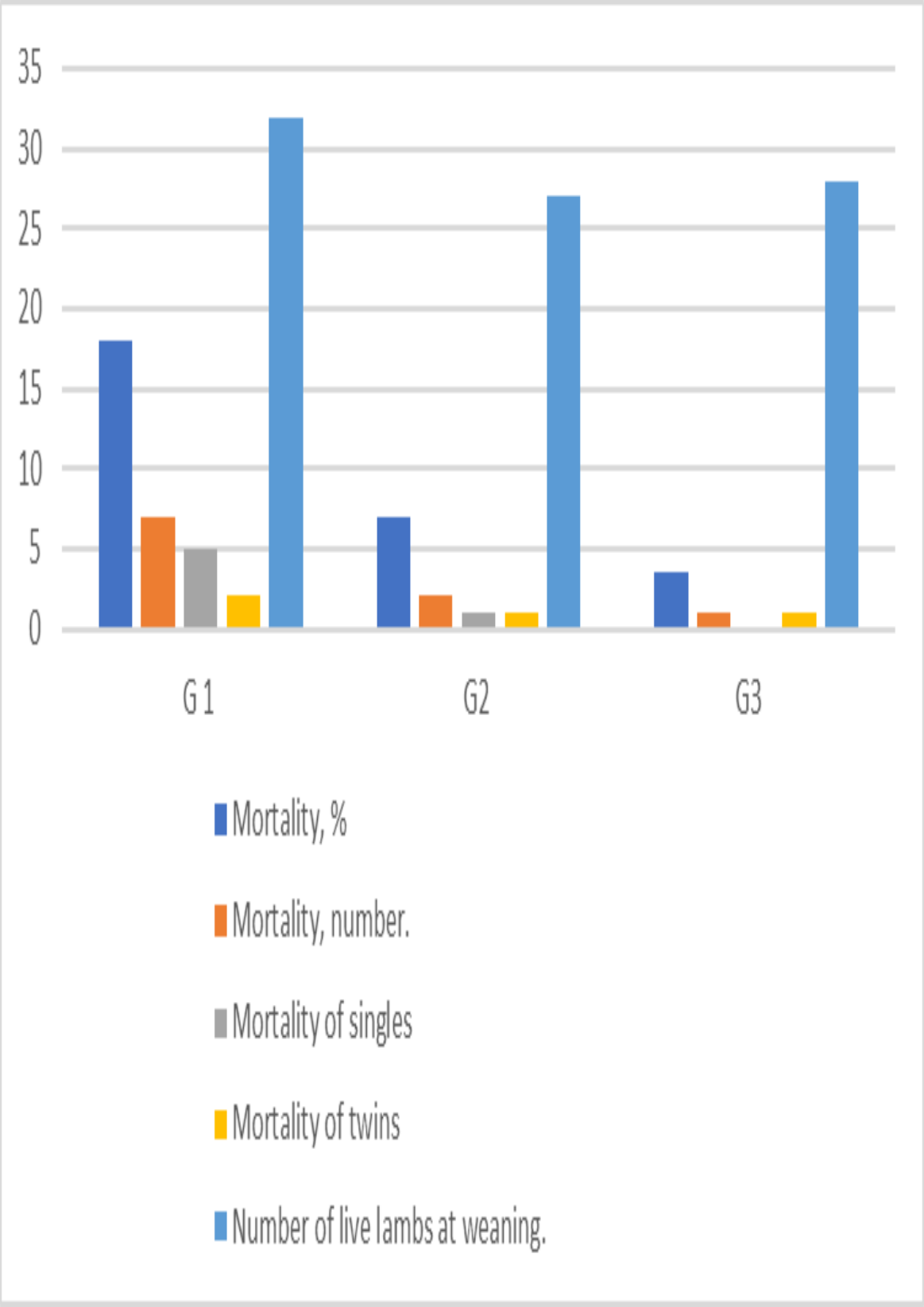
Mortality of lambs under different suckling methods.

Parameter	[1] G 1	G2	G3	P value
Mortality, %	18	7	3.5	0.85
Mortality, number.	7	2	1	0.88
Mortality of singles	5	1	0	0.81
Mortality of twins	2	1	1	0.27
Number of live lambs at weaning.	32	27	28	0.15

[1] **G1=** group 1**; G2=** group 2**; G3=** group 3**.**

Figure (5)

Mortality of lambs under different suckling methods



4.3 Effect of dam weight:

The effect of dam weight on lambs' weight, lambs average daily gain and lamb's mortality are in Table 6 and figure 6. Only average daily gain was affected by dam weight (P <0.05). Other studied traits were not affected (P>0.05). Dam body weight at birth showed a positive and highly significant ($P \leq 0.01$) effect on the majority of growth traits (Kuchtík and Dobeš, 2006). It was found that ewe weight was significant sources of variation for lamb weights and daily gains on Bharat Merino (Dixit *et, al.,* 2001).

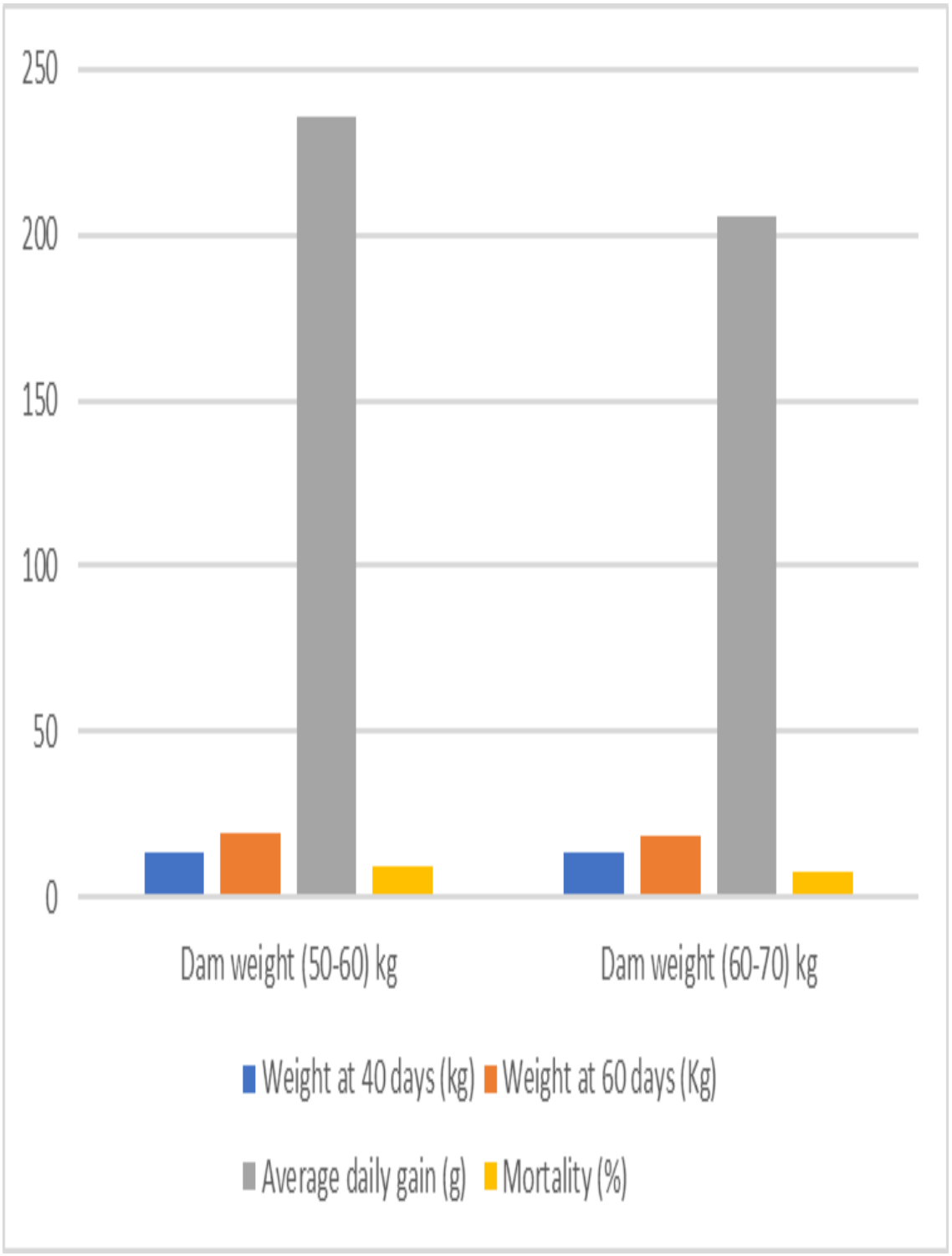
Table 6

The effect of dam weight on lambs' weight, lambs average daily gain and lamb's mortality.

Trait	**Dam weight (50-60) kg**	**Dam weight (60-70) kg**	***P* values**
Weight at 40 days (kg)	13.42	13.00	0.512
Weight at 60 days (Kg)	19.09	18.23	0.230
Average daily gain (g)	236	206	0.032
Mortality (%)	9.3	7.8	0.850

Figure (6)

The effect of dam weight on lambs' weight, lambs average daily gain and lamb's mortality.



4.4 Effect of liter size:

The effect of liter size on lambs' weight, lambs average daily gain and lamb's mortality are on table 7 and figure 7. Litter size has no significant effect ($P \geq 0.05$) on total weight gain and average daily gain of lambs. Also, mortalities were not affected by these parameters (Table 8). In contrast, as reported by previous research litter size significantly *(*$P<0.05$) increase in single borne lambs than twins (Miguel Mellado *et, al*, 2016). Vatankhah and Talebi (2009) studied the effect of type of birth (litter size), Lamb on lamb's mortality rate and reported similar results as in our study where that type of birth affects mortality rate, lamb mortality rate was higher in twins. Single lambs had higher daily growth rate than multiple born lambs (Mohapatra Arpita, *et, al,*

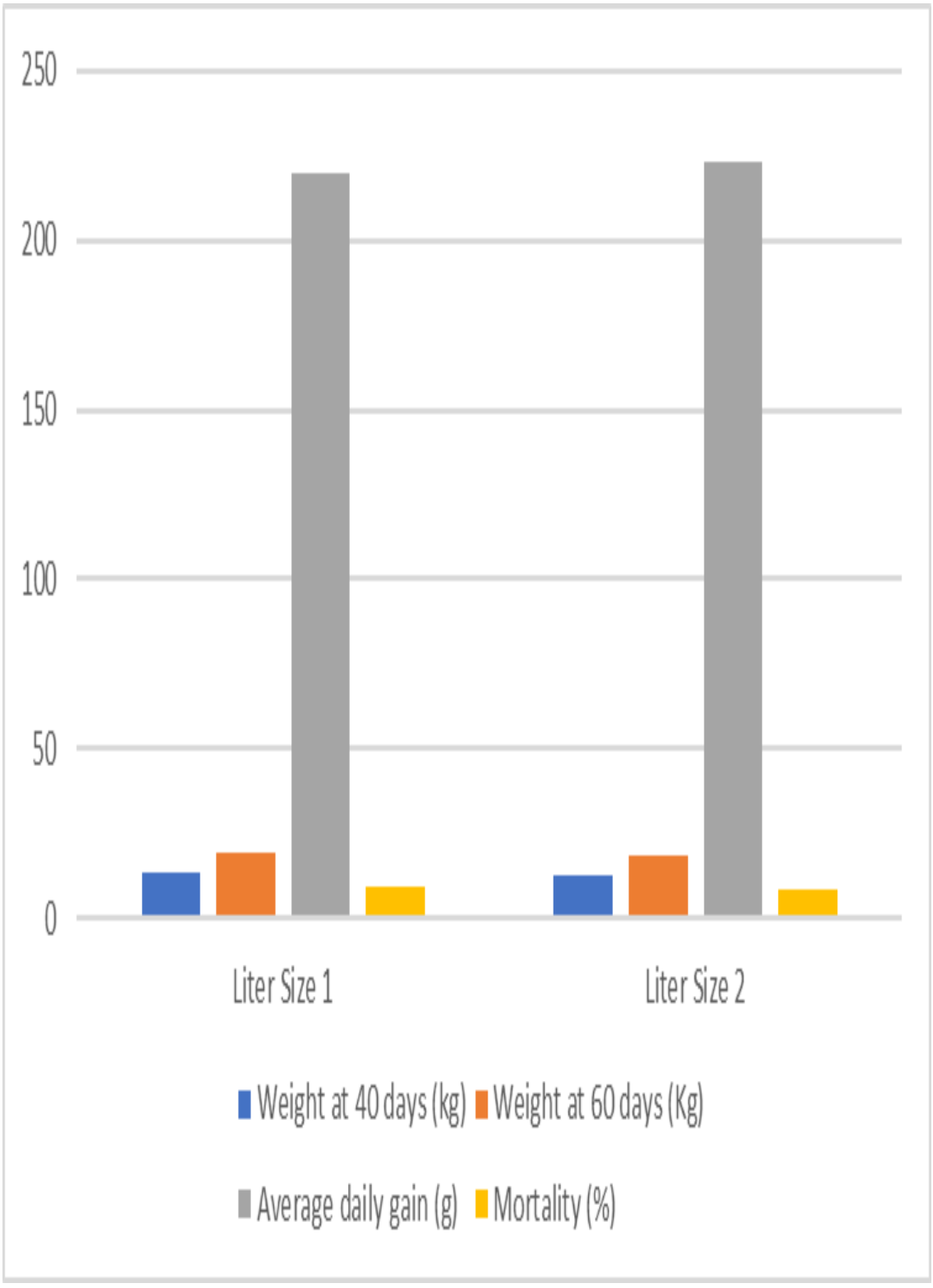
Table. 7

Effect of liter size on lambs' weight, lambs average daily gain and lamb's mortality

Trait	Liter Size 1	Liter Size 2	*P* values
Weight at 40 days (kg)	13.52	12.89	0.275
Weight at 60 days (Kg)	19.12	18.20	0.15
Average daily gain (g)	220	223	0.814
Mortality (%)	9.1	8	0.88

Figure (7)

Effect of liter size on lambs' weight, lambs average daily gain and lamb's mortality.



4.5 Effect of lamb sex:

The effect of lamb sex of the lambs on lambs' weight, lambs average daily gain and lamb's mortality are in table 8 and figure 8. Sex of lambs has no significant effect *(P*≥ 0.05) on total weight gain and average daily gain of lambs. Miguel Mellado *et al,* (2016) reported that lamb sex has no significant effect ((*P*>0.05) on birth weight, weaning weight, and average daily gain from lambing to weaning,

Vatankhah and Talebi (2009) reported similar results as in our study where the effect of six of lamb has no effect on lamb mortality rate. Also, it was found sex of lamb was the significant sources of variation for lamb weights and daily gains on Bharat Merino (Dixit *et, al,* 2001). Sex of lamb was effect significantly (*P*<0.05) lambs birth weight and growth rate from lambing to weaning, the overall least-square means for body weights were 2.18 kg, 10.58 kg 98.68 g for birth, weaning and growth rate respectively (Al-Bial and Singh,2012). Also, the effects of sex and birth types of lambs on weaning weight and average daily gain were studied by (Ayhan Ceyhan, *et, al,* 2009,) they found significant effect of these factors on studied traits.

According to Assan and Makuza (2005) sex had significant effects (*P*<0.001) on weaning weight and the average males' weights were heavier than females (*P*<0.001) at weaning in the mutton merino, Dropper. Also, single lambs were significantly heavier at weaning compared to twins. Gama, *et, al*., (1991) reported that mortality rate for male lambs was higher than females, and viability of lambs increased by prolificacy with lower birth weight.

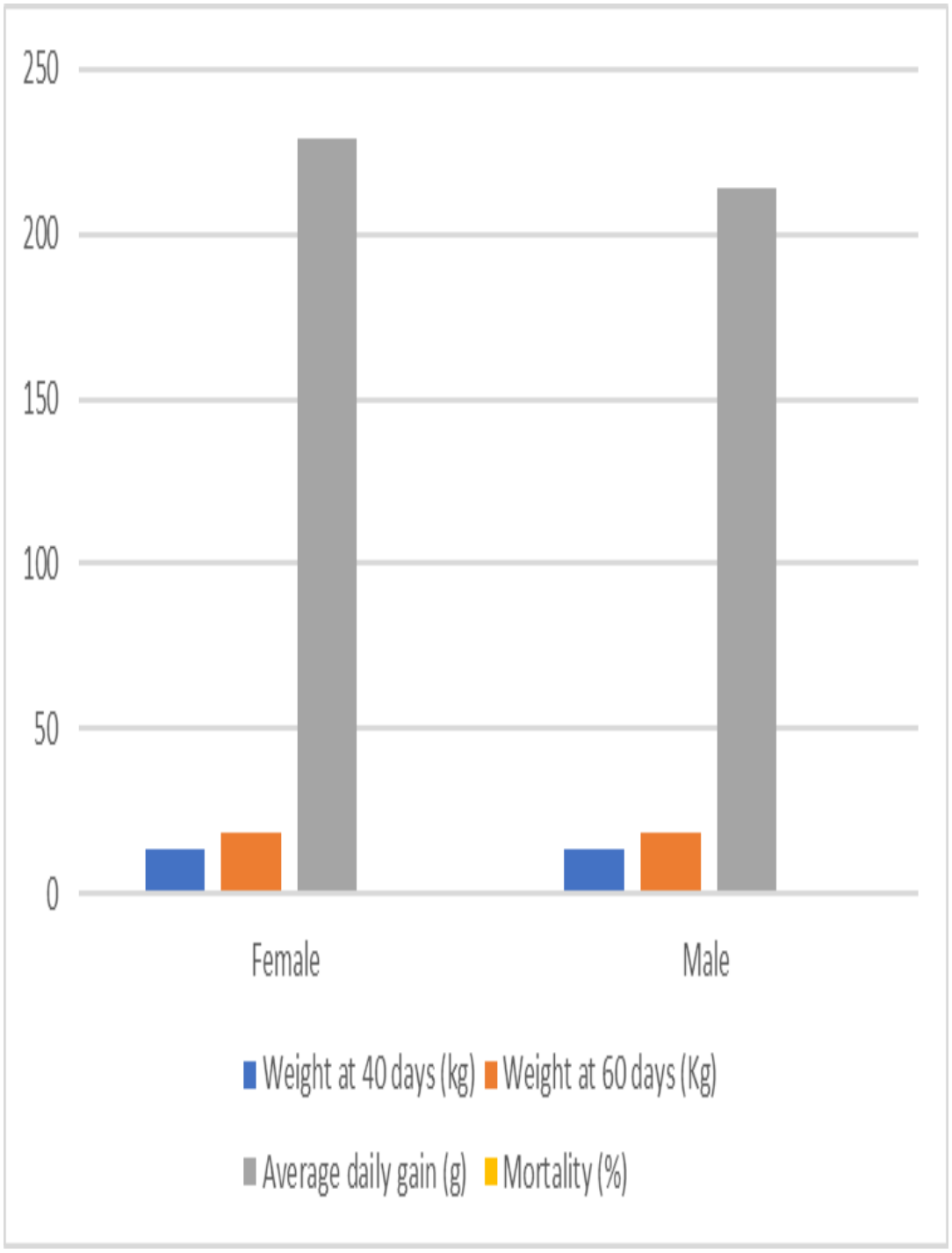
Table 8

Effect of sex of lambs on lambs' weight, lambs average daily gain and lamb's mortality

Trait	Female	Male	*P* values
Weight at 40 days (kg)	13.23	13.18	0.93
Weight at 60 days (Kg)	18.78	18.54	0.71
Average daily gain (g)	229	214	0.24
Mortality (%)	0.056	0.115	0.39

Figure (8)

Effect of sex of lambs on lambs' weight, lambs average daily gain and lamb's mortality



4.6 Effect of ewes' parity:

The effect of ewes' parity on lambs' weight, lambs average daily gain and lamb's mortality are in table 9 and figure 9. Ewes' parity has no significant effect ($P \geq 0.05$) on total weight gain and average daily gain of lambs. Vatankhah and Talebi (2009) reported similar results as in our study where the effect of age of dam (parity), on lamb's mortality rate and reported that age of dam has no effect on lamb mortality rate. Some studies showed the influence of parity on lamb mortality, birth weight, weaning weight, milk yield on different breeds in temperate countries (Mavrogenis 1996; de la Fuente *et, al*, 1997; Franci *et, al* ,1999; Ploumi and Emmanouilidis 1999; Sevi *et, al* ,2000).

It was found that age of dam was significant sources of variation for lamb weights and daily gains on Bharat Merino (Dixit *et, al,* 2001). The effects age of ewes on weaning weight and average daily gain was studied by (Ayhan Ceyhan, *et, al,* 2009,) they found significant effect of the age on studied traits.

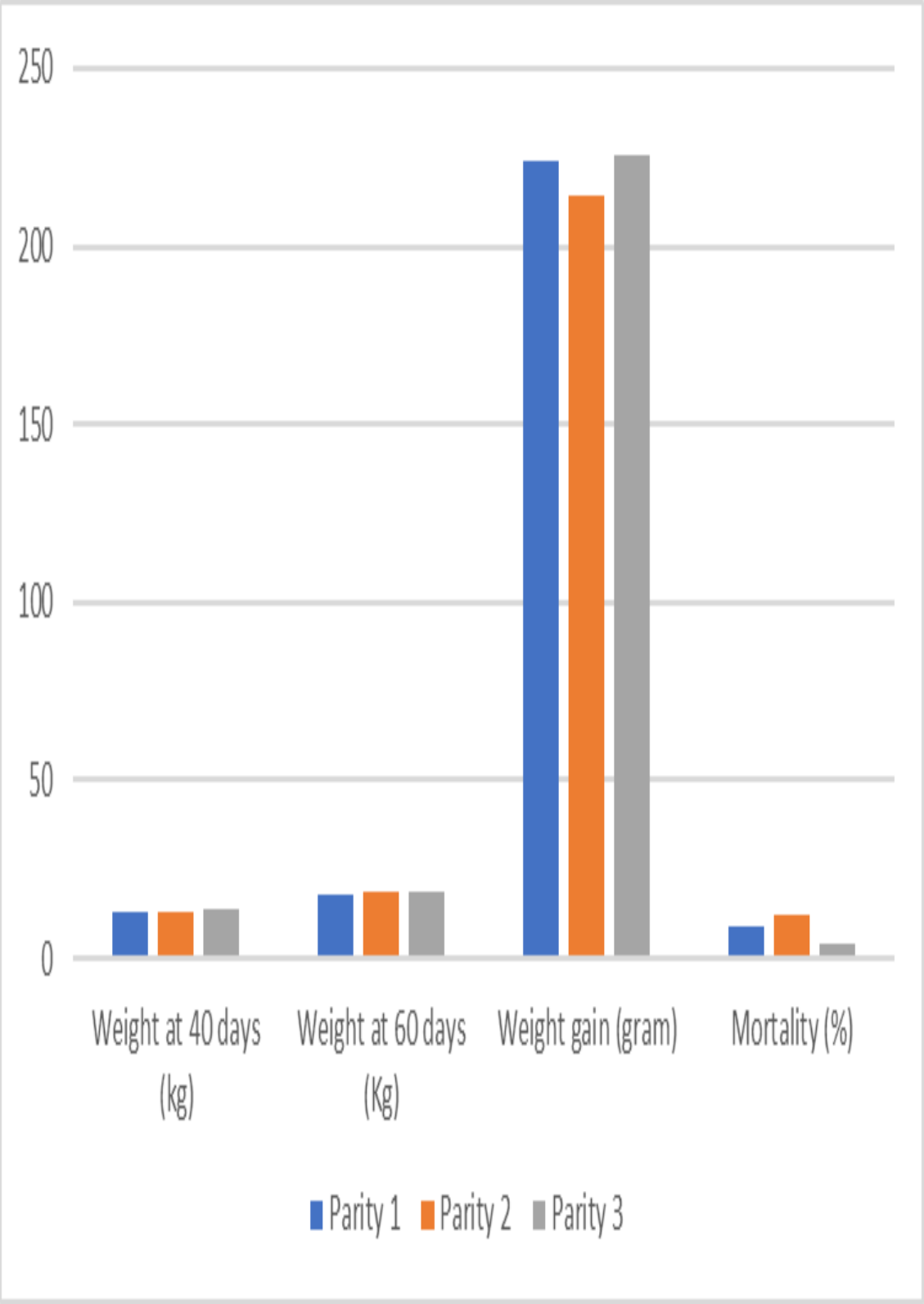
Table 9

Effect of ewes' parity on lambs' weight, lambs average daily gain and lamb's mortality

Trait	Parity 1	Parity 2	Parity 3	P values
Weight at 40 days (kg)	12.90	12.92	13.80	0.37
Weight at 60 days (Kg)	18.06	18.94	18.98	0.68
Weight gain (gram)	224	214	226	0.67
Mortality (%)	9	12.3	4.4	0.60

Figure (9)

Effect of ewes' parity on lambs' weight, lambs average daily gain and lamb's mortality



4.7 Cost of feeding milk replacers:

As shown in table 10 and figure 10. significant savings could be reached by feeding milk replacer to suckling lambs. Cost of milk per lamb was reduced from 120 USD to about 40 USD. A trial was conducted to evaluate the influence of non-genetic factors on lambs' growth during artificial suckling using milk replacer, three groups were introduced to artificial suckling, and the results on weaning weight did not have a significant difference, however, profitability increased from selling fresh milk. (Makovický *et, al.*, 2019).

Table 10

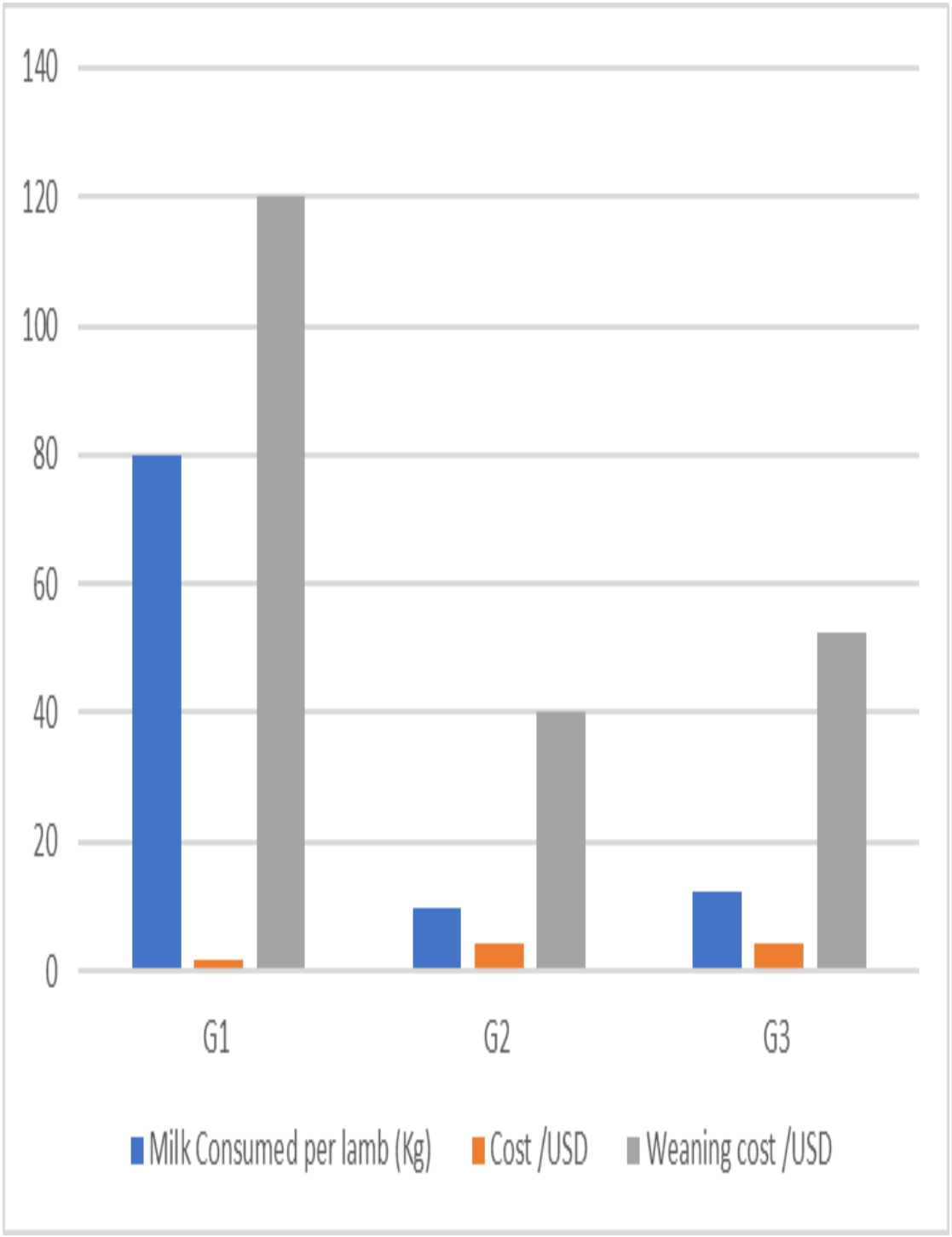
Number of lambs, milk consumption, mortality rate from lambing to weaning, by group.

[1] Group	Milk Consumed per lamb (Kg)	Cost /USD	Weaning cost /USD
G1	80	1.5	120
G2	9.70	4.24	40
G3	12.40	4.24	52.5

[1] **G1=** group 1**; G2=** group 2**; G3=** group 3**.**

Figure (10)

Number of lambs, milk consumption, mortality rate from lambing to weaning, by group.



4.8 Number of records for each trait in table 11.

Table 11

Fixed factors included in growth rate from lambing to weaning (GRL-W), weight at 60 days of age (W. at 60d), Mortality rate (MR), growth rate from lambing to weaning for group 2 and group 3 (GRL-W for G2 and G3), growth rate from lambing to weaning for group 1 (GRL-W for G1),total milk yield at 60 days (TMY60).

Factor[1]		**Number of records for each trait**					
		GR_{L-W} [2]	**$W_{at\ 60d}$**	**MR**	**GR_{L-W} for G2 and G3**	**GR_{L-W} for G1**	**TMY60**
Dam weight	50-60 kg	62	63	70	42	20	37
	60-70 kg	23	23	26	12	11	11
Parity	1	9	9	10	7	2	2
	2	52	52	59	33	19	31
	3	24	25	27	14	10	15
Liter Size	1	54	54	60	36	18	32
	2	31	32	36	18	13	16
Lamb Sex	F	42	43	47	23	19	
	M	43	43	49	31	12	
Suckling Method	A1	26	27	29			12
	A2	28	28	28			14
	N	31	31	39			22
Powder Milk consumed (kg)	9.68				28		
	12.40				26		
Natural milk consumed to weaning (kg)	70-79					13	
	80-91					18	

[1] **F** = Female; **M=** Male**; G2**= Artificial suckling 24 hours; **G3**= Artificial Suckling 4 times per day; **G1**= Natural Suckling.

[2]**GR_{L-W}**= growth rate from lambing to weaning; **$W_{at\ 60d}$**= weight at 60 days of age**; MR=** Mortality rate; **TMY**= total milk yield at 60 days.

Chapter Five

Conclusions and Recommendations

5.1 Conclusions:

1. It was concluded that significant reduction will be achieved through feeding milk replacers to suckling lambs. These saving is expected from the reduction in milk expenses and the significant reduction of mortalities.
2. Suckling method had no effect ($P>0.05$) on weaning weight at age 40 days and 60 days of single lambs. Weaning weights at 40 days were 13.7, 12.83 and 13 kg for lambs in G1, G2 and G3, respectively.
3. The rate of mortality was affected ($P<0.05$) by suckling method. Mortality rate
4. decreased from 18% in G1 to 7% and 3.5% in G2 and G3, respectively. Most of dead lambs were in single lambs. Liter size and suckling method had no effects ($P>0.05$) on total weight gain and average daily gain of lambs. Also, mortalities were not affected by these parameters.
5. Sex of lambs and suckling method had no effect *(*$P>0.05$) on total weight gain and the average daily gain. Lambs total gain and average daily gain were not affected ($P>0.05$) by numbers of ewe's parity.

5.2 Recommendations

It is recommended to adopt the practice of feeding milk replacers to suckling lambs. This practice, strengthening administrative matters and reduce pollution inside the farm, as indicated by this study, assure more return from sheep operations and then improves farms profitability through reducing feeding costs and the reduction of mortality.

List of Abbreviations

Abbreviation	Meaning
FAO	Food and Agriculture Organization.
AI	Artificial Insemination
AW	local Awassi
AF	Assaf
MoA	Ministry of Agriculture
G	Group
G1	Group 1 Natural Suckling
G2	Group 2 Artificial suckling 24 hours
G3	Group 3 Artificial suckling 4 times per day
S	Singles
T	Twins
P	Parity
TMY	Total Milk Yield
NARC	National Agricultural Research Center
PCLI	Palestinian Center for livestock Improvement
USD	United State Dollar

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Appendices

Appendix1: Composition of fresh milk consumed by lambs in G1.

No. of ewe	Suckling method	Fat	Solid not fat	Water	Density	Lactose	Protein	Total Solid	Freezing point
2	N	7.62	9.65	0	29.9	5.29	3.54	0.8	0.653
6	N	5.43	8.98	0	28.43	4.89	3.43	0.73	0.582
12	N	6.53	10.02	0	31.77	5.5	3.68	0.83	0.672
13	N	9.48	9.79	0	29.44	5.37	3.59	0.81	0.679
14	N	6.05	10.41	0	33.39	5.71	3.83	0.86	0.698
17	N	5.29	10.03	0	32.43	5.5	3.69	0.83	0.663
20	N	3.89	10.13	0	36	5.56	3.71	0.83	0.69
23	N	5.94	10.38	0	35.8	5.69	3.01	0.86	0.694
24	N	6.63	10.84	0	31.79	5.51	3.69	0.83	0.674
26	N	5.7	11.74	0	38.21	6.44	4.32	0.97	0.796
31	N	6.52	10.34	0	32.9	5.68	3.8	0.85	0.696
32	N	7.54	10.58	0	33.2	5.81	3.89	0.87	0.723
40	N	5.35	10.32	0	33.41	5.66	3.79	0.85	0.685
42	N	6.15	12.07	0	39.15	6.63	4.44	0.68	0.684
45	N	6.61	10.33	0	32.82	5.67	3.8	0.85	0.696
51	N	2.6	10.32	0	34.84	5.67	3.8	0.85	0.663
56	N	5.55	9.38	0	30.03	5.15	3.45	0.77	0.617
64	N	5.59	10.26	0	33.1	5.63	3.77	0.85	0.682
66	N	6.85	10.61	0	33.68	5.82	3.98	0.88	0.728
67	N	2.88	9.25	0	30.96	5.08	3.4	0.76	0.589
69	N	2.23	11.61	0	39.52	6.38	4.28	0.95	0.755
70	N	6.8	10.41	0	35.3	5.7	3.82	0.87	0.704
71	N	5.77	10.18	0	32.73	5.59	3.74	0.84	0.678

77	N	6.14	9.64	0	30.63	5.29	3.54	0.8	0.641
83	N	3.5	10.78	0	39	5.92	3.95	0.88	0.704
84	N	6.55	9.93	0	31.45	5.45	3.65	0.82	0.666
88	N	4.35	8.41	0	27.26	4.62	3.09	0.69	0.54
89	N	5.32	11.49	0	37.53	6.31	4.23	0.95	0.773
93	N	7.39	10.38	0	32.59	5.7	3.81	0.86	0.707
94	N	5.6	11.14	0	36.17	6.11	4.1	0.92	0.749
95	N	5.38	10.84	0	35.23	5.95	3.99	0.89	0.724
98	N	5.57	10.54	0	34.07	5.78	3.88	0.87	0.783
121	N	7.41	10.56	0	33.21	5.88	3.88	0.87	0.721
151	N	7.16	9.48	0	29.55	5.2	3.48	0.78	0.637
662	N	8.32	10.98	0	34.23	6.03	4.04	0.91	0.762
755	N	4.73	10.58	0	37.5	5.81	3.88	0.7	0.87
9525	N	8.01	10.48	0	32.63	5.75	3.85	0.87	0.72
*28	N	3.54	7.37	10.9	24.02	4.04	2.71	0.61	0.463

Appendix 2. The chemical composition of milk replacer

Item	amount/ present %
Protein	23%
Fat	20%
Fiber	0.2%
Minerals	9%
vitamin A	600000 IU
vitamin D3	8000 IU
vitamin E	150 m.gr
vitamin C	150 m.gr
Fe	100 m.gr
Iodine	0.2m.gr
Cu	3 m.gr
Mn	40 m.gr
Zn	40 m.gr
Se	0.3 m.gr

Appendix 3. Data for natural Suckling

Ewe ID	Suckling Method	Ewe WT	Parity	Liter Size	Ewe Breed	Lambing Date	Lamb Id	Lamb Sex	Lambing Wt.	Mortality	40-day Wt.	60 days weight (weaning)
2	N	62	2	2	XB	28/10/2020	3345	M	3.8	0	0	0
7	N	52.5	2	1	XB	25/11/2020	1281	F	3.85	0	0	0
12	N	62	2	1	XB	19/12/2020	2348	F	5.5	1	16.7	22.6
14	N	57	2	1	XB	21/12/2020	3215	M	4.5	1	16.2	22.35
18	N	60	2	1	XB	20/10/2020	2317	M	4.6	0		
23	N	65	3	2	XB	19/12/2020	3222	M	4.5	1	16.2	22.9
23	N	65	3	2	XB	19/12/2020	1877	M	4.8	1	15.75	15.35
26	N	62	2	2	XB	22/11/2020	1846	F	3.5	1	12.65	20.2
26	N	62	2	2	XB	22/11/2020	2881	F	3.45	1	11.95	17.95
28	N	60	4	2	XB	27/10/2020	1	F	3.3	0	0	0
40	N	56	3	1	XB	19/12/2020	1853	M	6	1	18.65	27.3
42	N	58	2	1	XB	3/1/2021	41250	F	4.7	1	15.1	20.3
43	N	60	2	1	XB	4/1/2021	21747	F	5.9	1	13	19.7
51	N	61	2	1	XB	22/11/2020	3352	F	4.3	1	16.5	24.9
52	N	58	2	1	XB	22/10/2020	1860	F	5.15	0	0	0
61	N	58	4	1	XB	19/12/2020	2300	M	3.9	1	11.4	15.35
64	N	55	3	1	XB	19/12/2020	3208	M	5.5	1	19.1	27.4

66	N	60	2	1	XB	19/10/2020	3260	M	4	0	0	0
67	N	60.3	3	2	XB	20/10/2020	2362	M	5.25	1	12	16.45
69	N	60	2	1	XB	22/11/2020	3369	M	4.1	1	13.75	19.2
70	N	58	3	2	XB	20/12/2020	2355	M	3.45	1	15	21.75
77	N	58	2	2	XB	28/11/2020	3246	M	3.85	1	14.75	18.2
83	N	56	3	2	XB	20/10/2020	3239	F	4.5	1	13.55	19.2
84	N	58	2	1	XB	22/11/2020	1884	F	4.3	1	15.35	22.2
88	N	57	2	1	XB	5/12/2020	7816	F	4.95	1	9.85	22
89	N	58	2	1	XB	4/12/2020	7823	F	4.55	1	13.85	18.8
93	N	60	2	1	XB	6/1/2021	7830	M	4.8	1	11	15
94	N	61	2	1	XB	8/12/2020	1761	F	5.95	1	14	19
95	N	60	3	1	XB	6/1/2021	7663	F	2.8	1	10.5	14
96	N	58	1	2	XB	26/12/2020	1778	M	5.1	0	0	0
97	N	58.5	1	2	XB	6/1/2021	7010	F	2.9	1	15.2	19
98	N	60	2	1	XB	17/1/2021	7311	F	3.4	0	0	0
102	N	60	2	1	XB	6/12/2020	275	F	2	1	10	15.5
121	N	65	2	2	XB	4/1/2021	7885	F	4.1	1	17.6	20.5
121	N	65	2	2	XB	4/1/2021	7878	F	4	1	13	19.1
151	N	58	2	2	XB	18/1/2021	17153	F	5	1	10.65	19.25
254	N	63	2	2	XB	18/1/2021	7146	F	4.6	1	10.65	19.25

662	N	59.5	1	1	XB	3/12/2020	7359	F	4.2	1	13	18.5
1	N	58	3	1	XB	3/12/2020	2	M	4.05	1	13.3	18.5

Appendix 4. Data for Artificial Suckling group 2

Ewe ID	Suckling Method	Ewe WT.	Parity	Liter Size	Ewe Breed	Lambing Date	Lamb Id	Lamb Sex	Lambing Wt.	Mortality	40-day weight (weaning)	60-day wt.
3	A1	61	3	1	XB	24/11/2020	2874	M	4.5	1	14.9	17.8
6	A1	57.1	2	1	XB	20/12/2020	2829	M	4.15	1	11.25	13.95
8	A1	60	2	2	XB	27/10/2020	12287	F	4.9	0	0	0
10	A1	58	2	1	XB	29/11/2020	2294	F	5.2	1	15.8	22
11	A1	55	2	2	XB	22/11/2020	2805	F	3.8	1	14.5	20.95
11	A1	55	2	2	XB	22/11/2020	2324	M	3.75	1	14.2	20.45
13	A1	56	3	1	XB	21/12/2020	2843	F	5.25	1	16.35	21.95
15	A1	58	2	1	XB	27/10/2020	1792	F	6.1	-	-	-
17	A1	59	3	1	XB	25/11/2020	1723	F	4.5	1	14.1	19
20	A1	56	2	1	XB	21/12/2020	2331	M	4.65	1	15.95	21.85
28	A1	60	4	2	XB	28/11/2020	2867	M	5.5	1	16.7	22
31	A1	64	3	1	XB	27/11/2020	1236	F	6.05	1	13	18.5
63	A1	57	1	2	XB	24/12/2020	2201	M	3.1	0	0	0
67	A1	60.3	3	2	XB	19/10/2020	2386	M	3.45	-	-	-
70	A1	58	3	2	XB	20/12/2020	2812	F	3.45	1	15.8	18.95
75	A1	58	3	1	XB	24/11/2020	2836	M	7.25	1	18.9	21.1
82	A1	63	4	1	XB	22/11/2020	1822	F	5.67	1	16.05	22.4
83	A1	56	3	2	XB	20/12/2020	2393	F	3.8	1		18.75
96	A1	58	1	2	XB	5/12/2020	1785	F	2.7	1	9.4	14.2
101	A1	61	2	1	XB	8/12/2020	2287	F	4.6	1	13.25	20
111	A1	52	2	1	XB	26/12/2020	1229	M	3.45	1	10.3	15.2
113	A1	58	1	1	XB	4/1/2021	7342	F	5	1	15	20.8
114	A1	63	2	1	XB	14/1/2021	7694	F	5.1	1	11	18
119	A1	58	1	1	XB	14/1/2021	7328	M	4	1	11.5	18

182	A1	62	2	1	XB	17/1/2021	7861	M	5.5	1	11	19.1
254	A1	63	2	2	XB	19/1/2021	9182	M	5.3	1	10.7	16.75
422	A1	58	2	2	XB	16/1/2021	7854	M	3.5	1	10.6	19
501	A1	58	3	1	XB	5/12/2020	1243	M	3.65	1	9.1	14
796	A1	61	3	1	XB	18/1/2021	102	M	6	1	14.3	19.8
8511	A1	57	2	1	XB	22/12/2020	1709	F	3.5	1	10.2	16.9

Appendix 5. Data for Artificial Suckling group 3

Ewe ID	Suckling Method	Ewe WT.	Parity	Liter Size	Ewe Breed	Lambing Date	Lamb Id	Lamb Sex	Lambing Wt.	Mortality	40-day weight (weaning)	60-day wt.
1	A2	60	3	2	XB	28/11/2020	3284	M	4.4	1	12.8	19.7
1	A2	60	3	2	XB	28/11/2020	3291	F	3	1	11.1	20
2	A2	62	2	2	XB	28/11/2020	2850	F	3	1	9.2	13.75
4	A2	61	2	1	XB	7/11/2020	2225	M	6	0	0	0
5	A2	58	2	1	XB	12/12/2020	1250	F	5.35	1	16.75	23
8	A2	60	2	2	XB	27/11/2020	1808	M	4.1	1	13.65	16.6
9	A2	60	2	1	XB	4/12/2020	2249	F	6.35	1	18.1	23.5
10	A2	58	2	1	XB	9/12/2020	1274	F	6.1	1	14	20.8
16	A2	58	3	1	XB	22/11/2020	1716	M	4	1	13.55	17.65
32	A2	58	2	1	XB	4/12/2020	2232	M	5.6	1	14.35	24.5
56	A2	59	2	1	XB	3/12/2020	2256	M	4.45	1	14.95	19.8
63	A2	59	2	1	XB	3/12/2020	2263	F	5.5	1	18	23
63	A2	57	1	2	XB	3/12/2020	1267	M	2.1	1	13	17.5
77	A2	58	2	2	XB	28/11/2020	3277	M	3.55	1	11.7	16.9
91	A2	59	2	1	XB	27/11/2020	1891	F	4.65	1	14.15	18.2
97	A2	59	1	2	XB	6/12/2020	1212	M	3.5	1		18.5
120	A2	58	3	1	XB	19/12/2020	1747	F	5.1	1	10.95	17.6
122	A2	61	2	1	XB	15/1/2021	7908	M	5.2	1	10.5	16.5
123	A2	62	2	1	XB	16/1/2021	7678	M	7	1	12.1	19.2
128	A2	63	2	1	XB	15/1/2021	7700	F	6	1	12	16.7
136	A2	60	2	1	XB	18/1/2021	101	M	5.9	1	10.9	21
151	A2	58	2	2	XB	18/1/2021	7153	M	5.7	1	10.7	16.75
162	A2	60	2	1	XB	17/1/2021	7847	F	5		10.6	19
198	A2	58	3	1	XB	18/1/2020	7892	M	5.4	1	10.7	18
333	A2	59	1	1	XB	10/1/2021	7335	M	4.5	1	14.5	19.5

422	A2	58	2	2	XB	15/1/2021	7670	M	4.6	1	11.5	17
6654	A2	59	2	1	XB	14/12/2020	2218	M	6	1	16.3	21.4
9471	A2	65	2	1	XB	1/12/2020	1839	F	4.3	1	12.8	16.7
9525	A2	60	2	1	XB	12/12/2020	1730	M	6.4	1	11.5	20

Appendix 6. Consumption of fresh and powder milk for lamb.

no. natural lamb	consumption fresh milk in 60 day/L	no. lamb artificial suckling 1	consumption powder milk in 40 day/kg	no. lamb artificial suckling2	consumption powder milk in 40 day/kg
2348	82	2874	12.4	3284	9.68
3215	81	2829	12.4	3291	9.68
3222	82	2294	12.4	2850	9.68
1877	78	2805	12.4	1250	9.68
1846	81	2324	12.4	1808	9.68
2881	79	2843	12.4	2249	9.68
1853	91	1723	12.4	1274	9.68
41250	81	2331	12.4	1716	9.68
21747	79	2867	12.4	2232	9.68
3352	82	1236	12.4	2256	9.68
2300	75	2812	12.4	2263	9.68
3208	88	2836	12.4	1267	9.68
2362	78	1822	12.4	3277	9.68
3369	80	2393	12.4	1891	9.68
2355	81	1785	12.4	1212	9.68
3246	78	2287	12.4	1747	9.68
3239	80	1229	12.4	7908	9.68
1884	82	7342	12.4	7678	9.68
7816	80	7694	12.4	7700	9.68
7823	77	7328	12.4	101	9.68
7830	75	7861	12.4	7153	9.68
1761	80	9182	12.4	7892	9.68
7663	75	7854	12.4	7335	9.68
7010	78	1243	12.4	7670	9.68
275	74	102	12.4	2218	9.68

7885	80	1709	12.4	1839	9.68
7878	79			1730	9.68
17153	80				
7146	80				
7359	82				
2	79				

Appendix 7. Fixed factors included in growth rate from lambing to weaning (GRL-W), weight at 60 days of age (Wat 60d), Mortality rate (MR), growth rate from lambing to weaning for group 2 and group 3 (GRL-W for G2 and G3), growth rate from lambing to weaning for group 1 (GRL-W for G1),total milk yield at 60 days (TMY60).

Factor[1]		Number of records for each trait					
		GR_{L-W} [2]	**$W_{at\ 60d}$**	**MR**	**GR_{L-W}** for **G2** and **G3**	**GR_{L-W}** for **G1**	**TMY60**
Dam weight	50-60 kg	62	63	70	42	20	37
	60-70 kg	23	23	26	12	11	11
Parity	1	9	9	10	7	2	2
	2	52	52	59	33	19	31
	3	24	25	27	14	10	15
Liter Size	1	54	54	60	36	18	32
	2	31	32	36	18	13	16
Lamb Sex	F	42	43	47	23	19	
	M	43	43	49	31	12	
Suckling Method	A1	26	27	29			12
	A2	28	28	28			14
	N	31	31	39			22
Powder Milk consumed (kg)	9.68				28		
	12.40				26		
Natural milk consumed to weaning (kg)	70-79					13	
	80-91					18	

[1] F = Female; M= Male; G2= Artificial suckling 24 hours; G3= Artificial Suckling 4 times per day; G1= Natural Suckling.
[2] GR_{L-W}= growth rate from lambing to weaning; $W_{at\ 60d=\ weight}$ at 60 days of age; MR= Mortality rate; TMY= total milk yield at 60 days.

Appendix 8. Summary of the influence (P values) of the fixed-effect factors on growth rate from lambing to weaning (GRL-W), weight at 60 days of age (Wat 60d), Mortality rate (MR), growth rate from lambing to weaning for group 2 and group 3 (GRL-W for G2 and G3), growth rate from lambing to weaning for group 1 (GRL-W for G1),total milk yield at 60 days (TMY60)

Fixed Effect Factor	P values						
	$GR_{L\text{-}W}$[1]	W_{at40d}	$W_{at\ 60d}$	MR	$GR_{L\text{-}W}$ for G2 and G3	$GR_{L\text{-}W}$ for G1	TMY60
Dam weight	**<0.05**		0.23	0.85	**<0.05**	0.84	0.41
Parity	0.67		0.68	0.60	0.65	0.946	0.68
Liter Size	0.814		0.15	0.88	.0.95	0.810	0.14
Lamb Sex	0.24		0.71	0.39	0.189	0.595	
Suckling Method	**<0.001**		0.34	**<0.05**			0.56
Powder Milk consumed to weaning (kg)					0.256		
Natural milk consumed to weaning (kg)						**0<.001**	

[1]**$GR_{L\text{-}W}$**= growth rate from lambing to weaning; **$W_{at\ 60d}$= weight** at 60 days of age**; MR=** Mortality rate; **$GR_{L\text{-}W}$ for G2 and G3=** growth rate from lambing to weaning for group 2 and group 3**; $GR_{L\text{-}W}$ for G1=** growth rate from lambing to weaning for group 1; **TMY**= total milk yield at 60 days.

Appendix 9: Summary of the influence (P values) of the fixed-effect factors lambs growth rate from lambing to weaning (GRL-W) Mortality rate (MR), by milk quality analysis.

Fixed Effect Factor	P values	
	GR L-W 1.	MR
Fat	0.608	0.061
Solid Not Fat	0.977	0.155
Lactose	0.955	0.111
Protein	0.757	0.208
Total Solid	0.915	0.924

1GRL-W= Lambs growth rate from lambing to weaning; MR= Mortality rate.

Appendix 10. Number of lambs, milk consumption, mortality rate from lambing to weaning, TMY60, and by group.

Group	Total Ewes	Number of lambs	Milk Consumed per lamb (Kg)	Mortality Rate	TMY60 (kg)Per Ewe
G1 (Natural Suckling)	36	39	80	0.194	116
G2 (Artificial Suckling 24 hours)	29	29	9.68	0.06	138
G3 (Artificial Suckling 4 times a day)	27	29	12.40	0.002	104

Appendix 11. Lambs Lost, milk Consumed, Natural milk produced, Fresh Milk Value (US), Weaned Lambs Value (US), and Powdered Milk Value (US).

Group	Lambs Lost	milk Consumed	Natural milk produced	Fresh Milk Value (US)	Weaned Lambs Value (US)	Powdered Milk Value (US)
G1 (Natural Suckling)	7	2480	**4176**	**-2650**	**+2500**	**-**
G2 (Artificial Suckling 24 hours)	2	281	**4002**	**+6253**	**-625**	**-1229.3**
G3 (Artificial Suckling 4 times a day)	1	360	**3016**	**+ 4712.5**	**-312.5**	**-1575**
Net Gain (US				**7073.7**		

جامعة النجاح الوطنية
كلية الدراسات العليا

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

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الملخص

تهدف هذه التجربة إلى دراسة تأثير أنظمة الرضاعة المختلفة على أداء الحملان ومعدل النقوق تم استخدام ما مجموعه 97 حملا رضيع في الدراسة، حيث بدأت فترات الحمل من تشرين الاول 2020 إلى كانون الاول من 2021. كانت عدد الولادات للنعاج 1 و2 و3 بطن، تم توزيع الحملان بشكل عشوائي وفقًا لطريقة الرضاعة إلى ثلاث مجموعات. المجموعة الأولى39 حملا ، الرضاعة الطبيعية حيث ترضع الحملان رضاعة مباشرة من امهاتها، المجموعة الثانية 29 حملا تتغذى بالكامل على بديل الحليب الرضاعة مفتوحة بدون تحديد وقت، والمجموعة الثالثة 29حملا تغذت رضاعة صناعية بمعدل 4 مرات يوميًا . وفصلت حملان المجموعة الثانية والثالثة عن امهاتها مباشرة بعد الميلاد واعطيت حليب اللبأ يدويا ثلاث مرات يوميا ولمدة ثلاثة ايام.

كانت نسبة الحملان المفردة 59% من المجموعة الاولى و٪41 من المجموعة الثانية توائم.ونسبة الحملان من الولادة الأولى والثانية والثالثة 8 و21 و28٪ على التوالي، كانت نسبة الحملان المفردة من المجموعة الثانية 62٪ بينما الحملان التوائم 38٪. وكانت الحملان من عدد ولدات النعاج الأولى والثانية والثالثة بنسبة 14و48 و38٪ على التوالي. ومع ذلك،كان 69 ٪ من المجموعة الثالثة من الحملان المفردة.معظم الحملان المفردة 44٪ والتوائم 21٪ كانت من الولادة الاولى والثانية والثالثة للنعاج.

أظهرت نتائج هذه الدراسةعدم وجود تأثيرلطريقة الرضاعة ($P> 0.05$) على وزن الفطام في المجموعات الثلاث حيث كانت أوزان الحملان 13.7 و12.83 و13 كجم على التوالي عند عمر 40 يوم.بينما تأثرمعدل الوفيات ($P <0.05$) بطريقةالرضاعةحيث ا نخفض من 18٪ في ا لمجموعةالاولى إلى7% و 3.5٪ في المجموعةا لثانية والثالثةعلى التوالي وكان لها تأثيرا معنويا،كما بينت الدراسة ان معدل التوائم لم يكن له تأثيرا معنويا ($P> 0.05$)على معدل النفوق بينما لم يكن هناك أي تأثيرذو دلالة معنوية($P> 0.05$) للعوامل الأخرى على معدل النفوق، لم يكن هناك أي تأثيرمعنوي ($P> 0.05$) لطريقة الرضاعةاوالعوامل الاخرى على معدل الزيادة الوزنية

اليومية للحملان من الولادة وحتى الفطام كماأدى استخدام الحليب البديل الى تخفيض تكاليف تربية الحملان من الولادة وحتى الفطام ،تم تخفيض تكلفة الحليب لكل حمل من 120 دولار امريكي إلى حوالي 40 دولار امريكي .

نستنتج من التجربة الى ان استخدام الحليب البديل في تغذية الحملان خلال فترة الرضاعة يؤدي الى تقليل النفوق مع الحفاظ على معدل النمو بالمقارنة مع الرضاعة الطبيعية وعليه يوصى باستخدام الحليب البديل في رضاعة الحملان لما له من أثر إيجابي في تقليل تكاليف التربية وتقليل نسبة النفوق من الولادة وحتى الفطام.