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COMPARATIVE STUDY OF YIELD AND MILK COMPOSITION FROM AWASSI AND AWASSI-CHIOS EWES

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AN ABSTRACT OF THE THESIS OF

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Title: Comparative study of yield and milk composition from Awassi and Awassi-Chios ewes.

Since milk and meat production are the factors that contribute most to the income from a flock of sheep, the present study was undertaken to evaluate the effects of crossbreeding on milk production, milk composition and growth rate of the lambs.

Compared with the purebred Awassi ewes, the crossbred ewes (Awassi rams x Chios ewes) produced more milk ($P < .01$) at 70 days. Milk collected at 85 days from crossbred ewes was richer in protein, ash and lactose.

Lambs from crossbred ewes weighed more than lambs from purebred ewes and gained more weight from birth to five months of age.

Correlation between milk composition and growth rate of the lambs were negative while correlation between milk yield and growth rate were positive but not significant.

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I. INTRODUCTION

Milk and meat production are of fundamental and practical importance in all farm mammals. With dairy cattle in particular, extensive study of milk secretion and meat production have resulted in raising the efficiency of the animal production. Crossbreeding is one method of improving these traits. Many workers (Barnicoat, Karam, El-Sokkary, Sidwell) have reviewed and reported studies concerned with crossbreeding. Most of them have shown that crossbreeding does lead to increase in the number of lambs in their growth rate and in the high yield of milk produced by the ewes.

The Awassi is the predominant fat tail sheep in the Middle East. It is known as a hardy animal, resistant to disease and capable of enduring extremely unfavourable environmental conditions (Mason, 1967). It is a dual purpose animal producing both milk and meat, but the milk yield is low and the growth rate of the lambs is rather poor.

The Chios breed belongs to the semi-fat tailed sheep imported from the Greek island of Chios and characterized by high prolificacy (1.5-2 lambs/ewe) and high milk yield (300-350 kg/ewe/lactation period).

Crossing these two breeds may lead to an improved type of sheep.

The objective of this work is to study the effect of cross-breeding of Awassi and Chios on:

1. Milk composition of the ewes.
2. Milk consumption of the lambs suckling crossbred ewes

compared to milk consumption of lambs suckling straightbred ewes.

3. Differences in milk production between straightbred group of ewes and reciprocal crossbred groups.

II. REVIEW OF LITERATURE

In contrast with the abundant data available on the composition of cow's milk and the effect of crossbreeding of beef cattle, information on the composition of ewes' milk and crossbreeding of sheep is relatively sparse. Among the more extensive analyses which have been published are those of Barnicoat, Logan and Grant (1949), Sidwell et al. (1963), and El-Sokkary et al. (1949).

Methods of estimating milk production

Milk production of the ewe has been the subject of considerable research because it is the main factor affecting the growth of the lamb, particularly during the first week of life. One of the main difficulties encountered has been the selection of a suitable technique for measuring the milk yield of the ewe. The first attempt to determine milk production was made by Fuller and Kleinheinz (1904) as mentioned by Coombe et al. (1960), who over a period of two days separated the lambs from their mothers and weighed them before and after suckling six times daily. On the third day the ewes were milked five times by hand and this gave an average of 1.02 Pounds (lb) compared to 2.8 (lb) which had been obtained by the lambs.

The lamb suckling technique has since been the basis of the studies. The procedure of Fuller was followed by many workers, but each has varied in the number of sucklings per day and the intervals between the sucklings over the recorded period. Sahani (1963), Acharya and

Bawa (1971) and Seth (1971) estimated the milk yield by weighing the lambs before and after suckling three times a day for two months. The difference in weight of the lambs was recorded as the milk production of the ewes.

Whiting et al. (1952) assessed milk production by weighing the lambs before and after suckling six times a day at four hours interval.

The best practical measure of milk yield according to Robinson (1968), is the amount removed by the lamb and determined by the suckling technique. In Robinson's study, the lambs were removed from their dams for four hours then they were allowed to suckle without weight recording then again separated. The first suckling was used to standardize conditions in the udder. Later, the lambs were allowed to suckle every four hours and weighed before and after suckling.

One of the main objections to this technique was the separation of the ewe from the lamb causing upset of the ewe and the probable deleterious effects on milk secretion and ejection (Wallace, 1948). Wallace was the first to notice this distress when separating the lambs from their mothers on the night before the estimation had to be done. To avoid this, covered creeps for the lambs were built adjacent to their mother's pens. The lambs could be shut away into these creeps without causing any distress to the ewes. Furthermore, recordings were made at regular four hours intervals throughout the 24 hours.

Owen (1957) overcame this problem by fitting his ewes with udder covers so that ewes and lambs could graze together during the intervals between suckling. These covers have since been used by

Davies (1958). The lamb suckling technique has been criticized as tedious and time consuming especially in large flocks (Barnicoat et al., 1949). Barnicoat investigated two other methods for measuring milk yield of ewes: a small milking machine with teat cups adapted to fit the ewe udder proved to be unsatisfactory; and the hand milking technique, which was shown by Fuller (1904) to be unsatisfactory, has been improved by Barnicoat (1949) using intravenous injection of oxytocin. Barnicoat in his experiment administered pituitrin (Post-Pituitary extract) at the rate of ten units in five milliliters physiological saline solution to facilitate hand milking of seventeen ewes tested. Fourteen yielded 80-100% of their accumulated milk but the other three yielded only 75% or less due to the incomplete emptying of the udder. This technique was discarded and replaced by lamb suckling technique.

McCance (1959) has reported an extensive study into the use of such a technique for the estimation of milk yield of the ewe. He listed the following three requirements for a method of estimation of milk production:

a) The udder must be emptied to the same degree at the beginning and end of the period of observation.

b) The technique does not have to affect rate of milk production while it is being applied.

c) The rate of production of milk during the period of observation should be the same as for other periods to which the estimates were done.

McCance in his experiment injected the ewes with pituitary

extract before the milking and a test dose of pituitary extract was again given fifteen minutes after the first extraction of milk to assure emptiness of the udder. If more than ten ml were obtained from each udder the animal was subjected to another injection until complete dryness; usually two injections were enough to empty the udder. This technique was followed in investigating two, four, six hours intervals between each milking. McCance found that the two hours periods gave higher rates of milk production. In contrast to these findings, Wallace (1948), Munro and Inkson (1957) found no difference in the milk production while investigating one, two and four hours intervals between milking.

For Gardner and Hogue (1966), the two and a half hours intervals corresponded to the normal suckling of the lambs. Brouchard and Brisson (1969) and Wilson et al. (1970) milked their ewes manually after injection of ten I.U. of oxytocin. Coombe (1960) analyzed the two methods using the traditional lamb suckling technique based on Owen (1957) and the one using oxytocin followed by hand milking. The lamb suckling was discontinued after ten weeks because at that time the weight increase due to suckling was too small to be measured accurately and tended to give low values. Coombe claimed that the oxytocin was more convenient and the average daily yield obtained by oxytocin injection was seven ounces more than the lamb suckling technique.

Poulton and Ashton (1972) were in agreement with Coombe's results (1960). They analyzed the lamb suckling technique and hand milking after injection of oxytocin. They found that on the average, the yields determined by oxytocin were higher by 23.1% than those

determined by the lamb suckling method.

Karam (1971), and Eliya and Juma (1970) used a combination of hand milking and lamb suckling technique. The lambs were allowed to suckle and then the udder was milked dry by hand.

Eyal (1958) milked the ewes twice daily first by machine then stripped them by hand fifteen minutes later.

Schwulst et al. (1966) used a procedure that estimated both cow production and calf consumption. Cows and calves were separated for about four hours the afternoon before the test. The evening prior to the official test, the calves were allowed to nurse after which the cows were milked dry by machine. The morning of the test, the calves were individually weighed before nursing and then reweighed immediately after nursing. At this point the cows were milked dry by machine. Any milk obtained by machine was considered to be due to milk consumed by the calf. This milk plus the amount of residual milk was considered to be an estimate of the cow's total milk production for twelve hours period.

Production estimates

Sonmelides (1954) reported average milk yield of Chios ewes as 200 kg per lactation period per head. Colaghis (1967) reported higher values for the Chios breed compared to the Zackel type of sheep. The average milk yield of Chios was 250 kg in 220 days. The corresponding values for Zachel were 100 kg in 200 days. The Chios was used by Colaghis to upgrade the Zackel in milk and meat production.

Sonmez (1964) studied the milk production of three breeds of sheep in Turkey; Awassi, Sokiz (Chios) and Kivircik. He showed that

the average yields were 185, 205 and 56 kg respectively in average lactation periods of 27.1, 28.2 and 22.3 weeks. The high yields reached by individual Awassi and Sokiz lead Sonmez to conclude that these results indicated good scope for improving the milk production of these three breeds if proper selection is followed.

Eyal (1958) recorded the average milk yield of Awassi ewes, when machine milked and then hand stripped twice daily, to be 0.5 kg per milking.

Yarkin (1966) stated that Awassi sheep produced three to four times as much as sheep of any Turkish native breed. The milk yield ranged between 78.5-211.1 kg in 147-200 days with percent fat varying between 2.5-4.47% at the beginning of lactation and 11.6-10.85% at the end of lactation with average of 6.8%.

Choueiri et al. (1966) recorded the milk yield of 189 Awassi ewes in the period from 1959 to 1965. It was observed that the maximum milk yields were in the first four lactation periods after which it declined in the fifth and sixth period. The average milk yield was 225, 231 and 197 kg in the first, fourth and sixth lactation.

Finci (1957) stated that the milk yield of the ordinary Awassi ewes was raised from 123.8 kg up to 1000 kg per lactation within a period of 20 years. This means that there seems to be enough genetic constitution in this breed of sheep to allow for selection of these characters which are of economic importance to the animal wealth in Lebanon.

Karam (1971) found that total milk yield, based on twelve hours

milking interval, from Awassi ewes of different ages averaged 115.65 kg in 134.87 days. Age of the ewes had no significant effect on milk production. Milk yield increased after the first lactation and maintained more or less the same level thereafter. On the other hand milk yield from Awassi ewes was affected significantly by the type of birth and the number of lambs reared.

Banky (1949) found that milk yield from ewes that had twins was greater than that from ewes that had single lambs. Working with New Zealand ewes, Barnicoat et al. (1949) estimated overall average of milk to be 45-53 oz per day during the 10-12 weeks lactation period by a four years old ewe. Age of the ewe, number of lambs suckling and type of plan of nutrition had a marked effect on milk production. The average percentages of butterfat, solids non fat, protein, lactose, ash, calcium and phosphorus expressed as phosphorus pentoxide (P_2O_5) were 5.1, 10.89, 5.5, 4.67, 0.83, 0.27, and 0.36 respectively.

El-Sokkary et al. (1949) reported that the Rahmany ewes were significantly superior to the Awsemy in milk yield, milk protein, solids non fat and percent fat.

Peart (1967) found that Blackface ewes attained maximum daily milk yields three to four weeks after parturition. At this point twin-suckled ewes yielded about 50% more milk than single-suckled ewes. Milk yield thereafter declined but at different rates so that from about the eighth lactation week milk production from twin and single-suckled ewes was similar.

Butterworth et al. (1968) reported on the milk production and composition of Persian Blackhead ewes on two planes of nutrition.

The milk of ewes fed on a high plane of nutrition contained significantly more fat than that of ewes fed on a low plane of nutrition; values were 8.8 and 8.3% respectively. The mean milk yield of high plane ewes in twelve weeks was 67.8 compared to 37.8 kg for the low plane ewes. Ewes suckling twins gave significantly more milk than ewes suckling singles.

Coombe and Wardrop (1960) estimated average daily milk production of grazing ewes to be 38 oz by lamb suckling technique and 45 oz by oxytocin injection followed by hand milking.

Gardner and Hogue (1966) reported that the Hampshire ewes produced significantly more than the Corriedale ewes. The average daily milk yield was 2158 g for the Hampshire and 1438 g for the Corriedale. The percent fat was higher for the Hampshire than the Corriedale (9.2% to Hampshire, 8.1% Corriedale).

Wilson et al. (1970) reported milk production of (Columbia x Hampshire - Suffolk) ewes for four hours period at first six weeks and second six weeks to be 334 and 259 g respectively. The average of butterfat, solids - non fat and protein were 8, 8.8, 11, for the first six weeks, and 10.2, 4.4, 4.6% for the second six weeks.

Correlation of milk composition and production to live weights of the lambs

Using rate of gain as the criterion of growth efficiency, Barnicoat et al. (1949) found that the correlation coefficients between milk consumed and gains in live weight of the lambs were irregular from birth to three weeks of age. From four to six weeks, the correlation coefficients were 0.79 in 1941 and 0.82 in 1943. The correlation

coefficients were high at that period because lambs were able to consume all the milk produced and milk secretion was at its peak. From seven to twelve weeks correlation coefficients were low because lambs were no more dependent on their mother's milk.

Barnicoat et al. (1957) reported that milk composition (percent fat, solids non fat) had no significant effect on the growth rate of the lamb. Weight of milk rather than its nutritive value estimated from composition gave the best index of its lamb fattening qualities.

Wallace (1948) found correlations of live weight increase of lambs with ewe's milk yield as follows: 0-28 days, r = 0.92; 0-56 days, r = 0.83; 0-84 days, r = 0.72; and 0-112 days, r = 0.71. It was shown that for each additional pound of milk consumed by the lamb between birth and 28 days, there was an increase of one fourth of pound in live weight of the lamb at one month old.

Owen (1957) demonstrated that milk yield is the important factor influencing the growth of young lambs. The relationship is highest in early lactation when the lamb is wholly dependent on milk. The correlation coefficients were 0.83, 0.42 and 0.21 for the periods 0-4, 6-8 and 8-10 weeks respectively.

Butterworth et al. (1968) reported that the weight gain and milk consumption of lambs were significantly correlated during the periods 0-3 and 0-12 weeks, the 'r' values were 0.84 and 0.72 respectively.

Peart (1967) reported correlation coefficients as shown in the following table:

Lactation week	I_r =	II_r =	III_r =
1	0.54	0.24	0.61
2	0.56	0.83	0.73
3	0.77	0.50	0.42
4	0.67	0.62	0.84
5	0.37	0.51	0.67
6	-0.05	0.51	-0.13
7	0.55	0.80	0.03
8	-0.53	0.88	-0.03
9	0.13	0.88	-0.35
10	-0.25	0.87	-0.70
11	0.40	0.15	-0.37
12	-0.44	0.22	

Group I. Both ewes and lambs were fed ad libitum throughout.

Group II. Ewes fed ad libitum. Lambs offered about one third the quantity of solid food being consumed by group I.

Group III. Food used by the ewes was restricted to 9.2 g digestible organic matter/kg based on their mid-pregnancy weights. Lambs were fed ad libitum throughout.

In group I and II the correlation of daily milk intake with daily live weight gains of lambs were mainly negative from week six onwards, but within group II the correlations were positive. These results lead Peart to emphasize the importance of milk as a source of nutrients when solid food is inadequate.

Coombe and Wardrop (1960) reported that the correlations between lamb growth and milk yield of the ewes were significant up to the seventh week of lactation only.

Folman et al. (1966) reported correlations between amount of milk suckled by Awassi lambs and their weight gain to be 0.8 and 0.63 during the periods 1-4 and 5-8 weeks respectively.

Karam (1971) found the correlation coefficients between weaning weight and milk production of Awassi and Merino ewes to be 0.78 and 0.65.

Highly significant correlations between weight of lambs and the milk production of their ewes were observed by Acharya and Bawa (1971) in each of the three months of lactation. The values were 0.75, 0.69 and 0.61 for the first, second and third month respectively.

Highly significant correlations between milk yield of the dam and growth of the lamb were also found by Seth and Pandey (1971). The correlation coefficients were as follows: Bikaneri, 0.82; Crossbred, 0.92; Mandia, 0.67.

Gardner and Hogue (1964) reported correlation coefficients of milk yield with 90 day lamb weights as 0.83. The correlation coefficients between milk yield during the fourth and sixth weeks of lactation and total milk production were 0.87 and 0.86 respectively.

Wilson et al. (1970) reported the correlation coefficients

between milk production and composition traits with preweaning lambs to be as follows:

	1st six week	2nd six week
Milk production	0.5	0.38
Fat %	0.19	0.11
S.N.F. %	-0.02	0.08
Protein %	0.13	0.08

Slen and Clark (1963) found the following correlation coefficients between milk production and gain of twin lambs of Suffolk, Hampshire, Rambouillet, Canadian Corriedale and Romnelet breeds to be 0.36, 0.54, 0.65, 0.14 and 0.28 respectively. The corresponding values for single lambs were: -.10, -.24, .48, -.04, -.05.

Sahani (1963) studied the conversation of milk into body tissues up to the first four weeks period only, when the lambs were completely dependent on milk. On an average, the lambs consumed 24.08 kg of milk to gain 4.41 kg in live weight. The correlation coefficients between milk yield and gain in weight at one month was found to be 0.88, while at the third month was 0.48.

Similarly, Schaffert (1953) estimated that the lambs required 4.89 kg ewe's milk per kg live weight gain.

Eliya and Juma (1970) reported a correlation coefficient of 0.67 between weaning weight and milk yield of the ewe. Similar values were reported by Damanski and Efner (1963).

Melton et al. (1967) reported that the average daily gain and average daily milk production were significantly correlated only in

the initial month of a six month lactation period as follows: .58, .38, .01, .19, .27, .03. Correlation between calf weight gain and percent fat and solids non fat were near zero.

All the above results illustrate an initially high but declining effect of milk yield on growth of the lamb or on the calf.

Heterosis

Sidwell (1964) compared birth weight and weaning weight of purebred and crossbred lambs. The crosses were made between Hampshire, Shropshire and Merino breeds. For the purebreds, the mean birth and weaning weights were 7.52 and 51.2 pounds respectively. Corresponding values for crossbreds were 8.07 and 58.2 pounds. This was an advantage of 0.55 pounds at birth and six pounds at weaning for the crossbred lambs. Iwan (1971) reported that the crossbred exceeded the purebred lambs by 3.7% in body weight. The mean survival rate of single offspring from crossbred ewes exceeded those of the purebreds by 3.5%.

Singh (1967) crossed ewes of six breeds of sheep developed at Minnesota with rams of same breed. Crossbreds excelled the purebreds for birth weight and 100 day weight of lambs by 4.7 and 8.1% respectively.

Johnson et al. (1964) compared 124 crossbred and 189 purebred cows sired by Holstein Brown Swiss and Jersey bulls. Increases for some crossbred groups were as large as 20% in milk production and 21% for butterfat production. The performance of crossbreds having Jersey and Brown Swiss parentage surpassed that of purebred Jerseys or Brown Swiss.

III. MATERIALS AND METHODS

The animals involved in this study were bred and kept at the Agricultural Research and Education Center (AREC) of the American University of Beirut (AUB) located in the Beqa'a valley.

All rams involved in this study were of the Awassi breed. The crossbred ewes were obtained by mating Awassi rams to Chios ewes. Twenty five ewes of this production were again mated to Awassi rams. The purebred group was straightbred Awassi.

The lambing period of this study started December 20th 1972 and terminated towards the end of February 1973. Most of the lambings occurred in January 1973. The weight of the lambs were recorded few hours after lambing and after thirty days for five consecutive months. The weight gain was calculated and recorded for each month.

Milking records

Milk production was measured and recorded when the lambs were seventy and eighty five days old starting February 28th, 1973 till May 18th of the same year. The lambs were separated from their dams on the evening before the day on which the estimation was to be made. The ewes were milked dry by hand twelve hours after being separated from their offsprings and the amount of milk was measured and considered on twelve hour basis.

Chemical analysis of milk

In addition to the measurement of milk yield at seventy and eighty five days numerous determinations of fat, moisture, solids - non fat, ash, calcium, phosphorus, protein and lactose were made.

Butterfat percentage was determined according to the Babcock standard method (A.O.A.C. 1965, 15.03) and reported as percent butterfat in milk. Moisture was determined according to A.O.A.C. (1965, 15.014) by evaporating five g sample in water bath and then drying in an oven set at 105°C when sample container is cooled and weighed. The results were expressed as percent moisture. The dried samples in crucibles were ignited in a muffle furnace set at 500°C for 12 hours. The difference in weight resulting from ignition was calculated and expressed as percent ash. Calcium was determined by permanganate titration of the oxalate (A.O.A.C. 1965, 13.014) phosphorus was determined by the Vanadomolybdate method (A.O.A.C. 1965, 1.034).

Crude protein was determined using the total nitrogen method (A.O.A.C., 1965, 2.044). The percentage protein was calculated by multiplying the percent nitrogen present in each sample by the conversion factor 6.38.

Lactose was determined by using the gravimetric method of Munson and Walker (A.O.A.C., 1965, 15.028).

Solids - non fat was calculated by subtracting the total solids from the percent butterfat.

Analysis of data

The birth weights of lambs as well as their growth rate were calculated on three way basis:

a) Considering the twin born lambs as single.

b) Considering the twin born lambs as one (adding their weights).

c) Averaging the weights of twin born lambs and considering them as one.

The 't' distribution test was used to test any significant differences between the milk constituents of crossbred and purebred ewes at 70 and 85 days.

The 't' distribution test was also used to test any significant differences between the mean live weights of crossbred and purebred lambs (Snedecor, 1967, pp 59-60, 100).

The correlation coefficients between milk constituents (fat, solids - non-fat, protein, lactose), milk yield production and live weights of the lambs were calculated according to Snedecor (1967, pp 172-177).

IV. RESULTS AND DISCUSSION

The main objectives of this study were to determine the effects of crossbreeding (Awassi x Chios) on milk composition, milk production and growth rate of lambs.

Chemical composition of milk

Milk was collected at seventy and eighty five days after lambing and was analyzed for fat, solids non-fat, ash, calcium, phosphorus, protein and lactose.

The milk composition of crossbred and purebred ewes, at seventy days is shown in Table 1.

The mean concentration of percent milk fat for the crossbred ewes was 2.91% at seventy days compared to 2.8% for the purebred ewes' milk. The difference 0.11% was not statistically significant. The solids-non-fat (S.N.F.), ash, calcium, phosphorus, protein and lactose values were slightly higher for purebred ewes' milk than for the crossbred.

The milk composition at eighty five days for both crossbred and purebred ewes is shown in Table 2.

The percent fat for the crossbred ewes was 3.34% compared to 3.67% for the purebred. The difference 0.33% was not statistically significant .

However, the solids-non-fat, ash, protein and lactose were slightly higher for the crossbred ewes' milk than for the purebred.

Table 1. Chemical analysis and milk production of crossbred and purebred ewes at 70 days.

	Crossbred	Purebred	Difference
% Fat	2.91	2.8	0.11
% S.N.F.	11.98	12.40	-0.42
% Moisture	85.10	84.84	0.26
% Ash	0.93	0.99	-0.06
% Calcium	0.22	0.24	-0.03
% Phosphorus	0.12	0.15	-0.03
% Protein	5.31	5.54	-0.23
% Lactose	5.30	5.32	-0.02
Milk production kg/12 hr	0.64	0.47	0.17**

*$P < 0.05$

**$P < 0.01$

Table 2. Chemical analysis and milk production of crossbred and purebred ewes at 85 days.

	Crossbred	Purebred	Difference
% Fat	3.34	3.67	-0.33
% S.N.F.	12.55	12.14	0.41
% Moisture	84.07	84.19	-0.12
% Ash	1.00	0.91	0.99**
% Calcium	0.24	0.24	0.00
% Phosphorus	0.15	0.15	0.00
% Protein	5.89	5.34	0.55**
% Lactose	5.4	5.05	0.35*
Milk production kg/12 hr.	0.55	0.50	0.05

*$P < 0.05$

**$P < 0.01$

The percent ash for the crossbred ewes was 1.00 the percent protein was 5.89. The corresponding values for the purebred ewes' milk were 0.9 and 5.34. The differences 0.09 and 0.55 were statistically significant at the 1% level. The percent lactose was 5.4 for the crossbred, and 5.05 for the purebred ewes' milk the difference 0.35% was significant at the 5% level.

Tables 3 and 4 show the composition of milk at seventy and eighty five days for purebred (Awassi x Awassi) and crossbred (Awassi x Chios) respectively.

The mean concentration of milk fat in whole milk for both breeds was found to be much lower than the ones reported for these breeds of ewes. Finci (1957), Yarkin (1966), and Eliya and Juma (1970) recorded fat percentages of Awassi ewes' milk to be 5.8, 5.4, and 6.8% respectively. The fat percent recorded in this work is also lower than that generally found for ewes' milk.

Barnicoat et al. (1949), El-Sokkary (1949) and Ashton et al. (1964) recorded fat percentages as 5.5, 7.8 and 6.2% respectively.

Throughout lactation, fat percentage of whole milk increased in both breeds (purebred and crossbred) from seventy to eighty five days (Tables 1 and 2). The percent fat of the purebred Awassi was 2.8 at seventy days and 3.67 at eighty five days. The difference 0.87 was significant at the 1% level. The percent fat of crossbred ewes' milk was 2.91 at seventy and 3.34 at eighty five days the difference 0.43 was not statistically significant. Such increases in the fat of ewes' milk have been reported by Perrin (1958), Ashton et al. (1964), Yarkin (1966). It is also in agreement with the results of

Table 3. Production and chemical analysis of purebred Awassi ewes' milk at 70 and 85 days.

	Purebred (70)	Purebred (85)	Difference
% Fat	2.80	3.67	0.87**
% S.N.F.	12.40	12.14	-0.26
% Moisture	84.84	84.19	-0.65
% Ash	0.99	0.91	-0.08
% Calcium	0.24	0.24	0.00
% Phosphorus	0.15	0.15	0.00
% Lactose	5.32	5.05	-0.07
% Protein	5.54	5.34	-0.20
Milk production kg/12 hr.	0.47	0.50	0.03

*$P < 0.05$

**$P < 0.01$

Table 4. Production and chemical analysis of crossbred ewes milk at 70 and 85 days.

	Crossbred (70)	Crossbred (85)	Difference
% Fat	2.91	3.34	0.43
% Moisture	85.10	84.07	-0.03
% S.N.F.	11.98	12.55	0.57
% Ash	0.93	1.00	0.07
% Calcium	0.22	0.24	0.02
% Phosphorus	0.12	0.15	0.03
% Protein	5.31	5.89	0.58
% Lactose	5.30	5.40	0.10
Milk production kg/12 hr.	0.64	0.55	-0.09

*$P < 0.05$

**$P < 0.01$

Nickerson (1960) for the trend in cow's milk.

The mean total crude protein concentration for the two breeds ranged between 5.31-5.89% as compared with values of 5.5 and 5.3% found by Barnicoat et al. (1949), and Ashton et al. (1964).

However, Brouchard and Brisson (1969), Whiting et al. (1952), El-Sokkary (1949) reported lower levels for protein concentration. The values recorded were 4.7, 4.5 and 3.9% respectively.

The mean values of 0.24 and 0.22% for calcium over the lactation period for both breeds are in close agreement with the values of 0.19, 0.21, 0.2% quoted by Ashton et al. (1964), Barnicoat et al. (1949), Ashton and Yousef (1966) and considerably higher than the mean value of 0.13% for cow's milk reported by Ling (1956, p 50).

The mean values of 0.12, 0.15% for phosphorus were slightly lower than the values 0.16% quoted by Ashton et al. (1964).

The mean values of 5.05 to 5.4% for lactose found in this study were higher than the values reported by Barnicoat (1949, 1957), Godden and Puddy (1935), Perrin (1958), and Ashton et al. (1964). These workers have also reported increases of varying degrees in the total crude protein of ewe's milk over the lactation. Such significant variations were not shown in the present study, which agrees with the findings of Brouchard and Brisson (1969).

Milk production

The milk yield was recorded when the lambs were seventy and eighty five days old for both breeds on 12 hour basis.

The mean milk production data of the purebred ewes (Awassi x Awassi) and the crossbred (Awassi x Chios) on 12 hour basis is shown

in Tables 1 to 4.

The average milk yield production of the crossbred ewes at seventy days was 0.64 and 0.47 kg for the purebred ewes. The crossbred ewes have excelled the purebred ewes in milk production by 0.17 kg in 12 hour period and 0.34 kg in 24 hour period. This increase was statistically significant at the 1% level. As lactation advanced, the average milk yield of the crossbred ewes on 12 hour basis decreased from 0.64 kg at 70 days to 0.55 kg at 85 days. The difference (0.19 kg) was not found to be significant. On the other hand, the purebred ewes milk yield increased but not significantly from 0.47 to 0.5 kg.

In the present study milk production of Awassi ewes averaged one kg of milk daily as compared with earlier estimates of 116 kg in 135 days (Karam, 1971), and 106 kg in 142 days (Eliya and Juma, 1970). However, the milk yield of Awassi ewes in this investigation was much lower than the yield of ewes of the same breed in Palestine as reported by Finci (1957) who reported the average daily milk yield as 2.67 kg per ewe. The Turkish Awassi ewes produced on the average 185 kg of milk in 189 days as recorded by Sonmez (1964).

Choueiri et al. (1966) reported an average of 231 kg in 202 days.

On the other hand, average milk yield of Chios ewes as reported by Colaghis (1967) was 1.1-1.2 kg per day.

The milk yield of 1.3 kg per day for the crossbred ewes compared favourably with other types of breed. Owen and Ingleton (1963) reported milk yield as 1.3 kg per day, and Barnicoat et al. (1949) 1.2 kg per day. Treacher (1970) using machine milking without

administration of oxytocin reported mean milk yields of 0.98, 0.72 and 0.45 kg per day depending upon the level of nutrition. Treacher (1970) however, considered that these yields without the administration of oxytocin may be 60-80% lower than those determined. All workers studying the variation of milk yields with advancing lactation such as Poulton and Ashton (1972), Barnicoat (1957), Treacher (1970), and Owen and Ingleton (1963) reported that yield increases from the first week and reaches a maximum peak at 2-3 weeks of lactation then decreases slowly. In the present study, milking was performed without the administration of oxytocin and the volume of milk was collected at seventy and eighty five days.

Milk yield in relation to type of birth

The mean yield production according to type of birth of the lambs (single or twin) is shown in Table 5.

Table 5. Milk yield of crossbred ewes according to type of birth of the lambs.

	Milk yield at 70 days kg/12 hr	Milk yield at 85 days kg/12 hr
Ewes suckling single lambs	0.67	0.56
Ewes suckling twin lambs	0.60	0.52

The mean milk yield production according to type of birth was calculated for the crossbred ewes only as the purebred ewes gave two multiple births of which one died.

The results in Table 5 showed that the milk yield of ewes suckling twins and the milk yield of ewes suckling singles did not differ significantly. These results are in direct contrast with most of the previous works reported on sheep milk.

Slen and Clark (1963) reported that ewes suckling twins produced significantly more milk ($P < 0.01$) than those suckling singles with the difference being greatest for the first two weeks of lactation. Similarly Banky (1949), Karam (1971) found that milk yield from ewes that produced twins was greater than that from ewes which produced single lambs.

Other workers such as Davies (1958), Alexander and Davies (1959), and Peart (1967) found that the milk yield was affected in the same manner by the number of lambs suckled but not by the number of lambs born.

On the other hand, Wilson et al. (1970) reported that milk production and composition were not affected by the breed of the ewe or the type of birth of the lambs.

Gardner and Hogue (1964) observed that ewes with twin lambs secreted more milk with greater fat content but this was contrasted in later study by Gardner and Hogue (1966) who observed a non-significant difference between milk of ewes suckling twins or singles.

Reproductive efficiency of the crossbred and purebred ewes

The reproductive efficiency of the crossbred and purebred ewes is shown in Table 6.

The fertility; measured by percent of ewes lambing of ewes

bred, was 100% for the crossbred ewes compared to 77% for the purebred ewes. The difference 28% found was highly significant.

The prolificacy, measured by percent of lambs born of ewes lambing, was 152% and 105.8% for the crossbred and purebred ewes respectively. Out of 25 lambings, 38 lambs were born to the crossbred ewes and out of 17 lambings, 18 lambs were born to the purebred ewes.

These traits are undoubtedly the best measure to test the producing ability of ewes within different breeds and their crosses.

Prolificacy can affect not only meat and lamb production but also can affect indirectly milk production. As it was mentioned earlier that ewes suckling twins produce usually more milk than ewes suckling singles. The 52% of multiple birth born to the crossbred ewes compared to the 11.7% of multiple birth born to the purebred ewes can affect milk yield production.

These results alone can justify the recommendation of crossbreeding for commercial purposes.

The reproductive ability was found to be higher in crossbred than in purebred matings. The findings agree with the work of Sidwell (1962) where the percent of prolificacy was 94 and 78 for the crossbred and purebred, respectively.

Live weights of the lambs

Data for birth weight and weight gain per month for the crossbred and purebred lambs are shown in Table 7.

The birth weights as well as the weight gain of lambs per month were calculated on three way basis:

a) Considering the twin born lambs as one (adding their

Table 6. Production efficiency of the crossbred and purebred ewes.

	Crossbred	Purebred
Number of ewes	25	22
Number of ewes lambing	25	17
Number of lambs born	38	19
Number of lambs dead after birth	2	1
Number of lambs dead	0	1
Number of twin born lambs	13	2
Percent lambing	100	77
Multiple birth percentage	52	11.7
Percent prolificacy	152	105.8

Table 7. Live weights of crossbred and purebred lambs (twins as one, twins as average, twins as single).

	Twins as one		Twins as average		Twins as single	
	Crossbred	Purebred	Crossbred	Purebred	Crossbred	Purebred
Birth weight	6.57**	4.53	4.72	4.51	4.56	4.28
Weight gain in kg/1st month	11.60	6.73	8.12**	6.70	7.63	6.35
Weight gain in kg/2nd month	9.49**	6.49	7.10*	6.47	6.16	6.13
Weight gain in kg/3rd month	12.61**	8.00	8.51	7.96	8.30	7.55
Weight gain in kg/4th month	11.52**	7.35	7.79	7.31	7.79	6.94
Weight gain in kg/5th month	10.60**	5.65	7.96**	5.63	7.57**	5.34

*$P < 0.05$

**$P < 0.01$

weights).

b) Considering the twin born lambs as single.

c) Averaging the weights of the twin born lambs and considering them as one.

The birth weights of the crossbred lambs were heavier in all three comparisons (twins as one, twins as single, twins as average). Tests of significance relevant to birth weights and weight gain per month are shown in Table 7.

Lambs born to crossbred ewes averaged 4.56 kg at birth whereas the lambs of purebred ewes averaged 4.28 kg. The difference 0.28 kg was not statistically significant (when twins considered as single). The birth weights of lambs from crossbred ewes reported in this study were similar to data reported by Fox et al. (1971).

On the other hand, Colaghis (1967) reported lower birth weights for the crossbred (Chios x Zackel) and purebred Zackel of 2.92 and 2.43 kg. Lambs from the crossbred ewes gained more weight than lambs from purebred ewes during the five month period of observation. The difference was highly significant at the first and fifth month.

Wiener (1967) reported that the crossbred lambs from Welsh ewes were on average heavier at birth and at weaning than the purebred.

Sidwell (1971) reported that increases in body weight due to crossbreeding were more evident in weaning weight and gain from birth to weaning than in birth weight.

Live weights of lambs according to sex

Data for live weights of lambs according to sex within the breed are shown in Table 8.

Sex had a highly significant source of variation on the weight of lamb at birth and their growth rate. Crossbred male lambs average 4.8 kg at birth compared to 4.3 for females while corresponding figures for purebred were 4.28 and 4.29 kg. The difference of 0.5 kg for the crossbred male over the crossbred females was significant at the 5% level.

The difference in weight gain of the crossbred male lambs and their females counterparts was highly significant at the first, third, fourth, and fifth month of age.

These results were slightly higher than the one presented by Hussain (1973, p 53) who reported the birth weight of crossbred male as 4.66 and female as 4.28 kg while the corresponding values for the purebred were 4.34 and 4.09 kg.

Significant effects due to sex were observed in other breeds of sheep. Karam (1971), and Santiago (1954) reported that male lambs grew heavier than female. However, Juma et al. (1969) and Brown et al. (1961) reported that birth weights and growth rate of the lamb were not affected by sex.

Live weights of lambs according to type of birth

The live weights of crossbred lambs according to type of birth are shown in Table 9.

The single crossbred lambs averaged 5.22 kg at birth. The crossbred twin lambs averaged 4.25 kg at birth. The difference of

Table 8. Live weights of lambs according to sex within the breed.

	Crossbred		Purebred	
	Male	Female	Male	Female
Birth weight	4.80*	4.30	4.28	4.29
Weight gain in kg/1st month	8.33**	6.67	6.34	6.37
Weight gain in kg/2nd month	6.25	5.71	6.83	6.43
Weight gain in kg/3rd month	8.80**	7.59	7.68	7.43
Weight gain in kg/4th month	8.21*	7.21	8.10**	5.79
Weight gain in kg/5th month	9.66**	4.48	7.53**	4.14

*$P < 0.05$

**$P < 0.01$

Table 9. Live weights of crossbred lambs according to type of birth.

	Single	Twins	Difference
Birth weight	5.22*	4.25	0.97**
Weight gain in kg/1st month	9.73	6.99	2.74**
Weight gain in kg/2nd month	14.42	5.10	9.32**
Weight gain in kg/3rd month	9.24	7.89	1.35**
Weight gain in kg/4th month	7.70	7.80	-0.10
Weight gain in kg/5th month	6.87	7.57	-0.70

0.97 kg was significant at the 1% level.

The difference in weight gain between single and twin born lambs was highly significant up to the third month of age when the twins tried to catch up in weight with their single counterparts and were no more dependent on mother's milk. This is well illustrated in Table 12 which denoted that the correlation coefficients between lamb growth and milk yield production started to decrease.

These results are in agreement with Fox et al. (1971). Highly significant differences for birth weight between single and twin Awassi lambs were observed by Juma and Faraj (1966).

Slen and Clark (1963) observed single lambs to be 1.7 pounds heavier ($P < .01$) at birth than twin lambs.

Sidwell (1964) reported that lambs born as twins and raised as singles were heavier than lambs born and raised as singles. Singh (1967) stated that the reverse is true.

Correlation

The correlation coefficient data of milk composition at seventy days and weights of crossbred lambs are shown in Table 10.

The correlation coefficients between live weights of lambs and percent butterfat, solids-non-fat, protein and lactose of crossbred ewes' milk at seventy and eighty five days were calculated. The results came to be irregular, negative or zero. Because the correlation coefficients of milk constituents of the crossbred ewes to the live weights of the lambs came to be negative, the corresponding values for the purebred group were not calculated.

Data reported in Tables 10 and 11 are in agreement with data

Table 10. Correlation of milk composition at 70 to live weight of crossbred lambs (twins as one).

	% Fat	% S.N.F.	% Protein	% Lactose
Birth weight	0.12	-0.03	0.27	-0.27
Weight gain in kg/1st month	-0.16	0.07	-0.02	-0.27
Weight gain in kg/2nd month	0.09	0.20	-0.24	-0.14
Weight gain in kg/3rd month	0.19	-0.04	0.32	-0.33
Weight gain in kg/4th month	0.11	0.10	0.27	-0.19
Weight gain in kg/5th month	0.07	0.04	-0.05	-0.9

Table 11. Correlation of milk composition at 85 days to live weight of crossbred lambs (twins as one).

	% Fat	% S.N.F.	% Protein	% Lactose
Birth weight	-0.12	0.13	0.28	-0.25
Weight gain in kg/1st month	-0.12	0.27	-0.11	0.38
Weight gain in kg/2nd month	0.12	0.28	0.0	-0.16
Weight gain in kg/3rd month	-0.04	-0.11	0.39	-0.29
Weight gain in kg/4th month	-0.10	-0.11	0.37	-0.24
Weight gain in kg/5th month	-0.24	0.03	0.13	-0.14

on cows reported by Melton et al. (1967). They reported correlation coefficients between calf weight gain and percent butterfat, solids-non-fat and total solids as zero. Similarly, Wilson et al. (1970) reported the values 0.11, -0.02 and -0.08 as correlation coefficients between lamb weights, percent fat, solids-non-fat and protein respectively. These results indicate that variation in milk composition is not important in determining lamb growth rate.

However, Barnicoat et al. (1949) reported that percent butterfat may influence the growth of the lamb as it contains twice as much energy as do carbohydrates or proteins.

Correlation between milk yield production and live weight of lambs

Tables 12 and 13 show the correlation coefficients between milk yield production, at seventy and eighty five days, and growth rate of crossbred and purebred lambs respectively.

The correlation coefficients between birth weight and milk yield were either negative or zero in both breeds. Positive but not significant correlations were found between milk yield production and weight gain of the lambs during the first three months of lactation. These correlations were generally lower than similar correlations reported in the literature. Damanski and Efner (1963), Eliya and Juma (1970) reported the correlation coefficients between growth rate of the lamb and milk yield as 0.7, 0.63 and 0.67 respectively.

Barnicoat (1957) reported that the correlation coefficients for the crossbred milk to lamb growth were higher than those of the purebred (0.75 to 0.64 at 0-12 weeks of age). Wilson et al. (1970)

Table 12. Correlation of milk yield production at 70 and 85 days to live weights of crossbred lambs.

	Twins as one		Twins as average		Twins as single	
	Milk at 70	Milk at 85	Milk at 70	Milk at 85	Milk at 70	Milk at 85
Birth weight	0.00	-0.10	0.28	0.13	0.29	0.14
Weight gain in kg/1st month	0.21	0.22	0.36	0.26	0.27	0.25
Weight gain in kg/2nd month	0.31	0.26	0.41	0.35	0.26	0.24
Weight gain in kg/3rd month	0.14	0.10	0.43	0.28	0.36	0.27
Weight gain in kg/4th month	-0.13	-0.06	-0.11	0.23	-0.05	0.03
Weight gain in kg/5th month	0.00	-0.20	0.14	0.04	0.05	0.03

Table 13. Correlation between purebred milk yield at 70 and 85 days to live weights of lambs.

	Twins as single	
	milk at 70	milk at 85
Birth weight	-0.13	-0.18
Weight gain in kg/1st month	0.16	0.19
Weight gain in kg/2nd month	0.10	0.12
Weight gain in kg/3rd month	0.14	0.13
Weight gain in kg/4th month	0.06	0.08
Weight gain in kg/5th month	-0.29	-0.20

and Coombe (1960) reported that the 'r' values for correlation decreased with increased age; Wilson reported 'r' to be 0.5 for the first six weeks and 0.38 for 6-9 weeks; Coombe reported it to be 0.69 from 0-4 weeks and 0.29 from 7-10 weeks.

Although lower than the correlation reported in the literature, the correlations reported in this study between the first and third month of lactation were positive and decreased with advancing age.

The data support the contention that there is a positive relationship between weight of the lamb and milk production of the ewe. The relationship is high in the early lactation when the lamb is dependent on his mother's milk but decreases when the lamb starts supplementing milk with solid food.

The quantitative aspects of the ewe's milk appear, however, to be of more practical significance than that of the qualitative aspects; hence, the correlation coefficients of fat, solids-non-fat, protein and lactose were negative while the correlation coefficients of milk yield were positive.

V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Milk production and lamb weight gain records were analyzed for 25 crossbred ewes (Awassi x Chios) and 22 purebred ewes (Awassi x Awassi). Milk production was measured and analyzed when the lambs were 70 and 85 days of age. Crossbred ewes produced 0.64 and 0.55 kg of milk at 70 and 85 days respectively. Corresponding figures for purebred ewes were 0.47 and 0.50 kg. A sample of milk was taken at 70 and 85 days and analyzed for percent butterfat, solids non fat, moisture, ash, calcium, phosphorus, protein and lactose. At 70 days the analysis of milk from crossbred ewes gave 2.91% butterfat, 84.10% moisture, 11.98% solids non fat, 0.93% ash, 0.22% calcium, 0.12% phosphorus, 5.31% protein and 5.30% lactose. Corresponding figures for purebred ewes' milk were: 2.8% butterfat, 12.4% solids non fat, 84.84% moisture, 0.99% ash, 0.24% calcium, 0.15% phosphorus, 5.32% lactose and 5.54% protein.

At 85 days milk from crossbred ewes had 3.34% butterfat, 84.07% moisture, 12.55% solids non fat, 1.00% ash, 0.24% calcium, 0.15% phosphorus, 5.89% protein and 4.4% lactose. Corresponding values for the purebred ewes milk were 3.67% butterfat, 12.14% solids non fat, 85.19% moisture, 0.91% ash, 0.24% calcium, 0.15% phosphorus, 5.05% lactose, 5.34% protein. The fertility was 100% for the crossbred and 77% for the purebred ewes. Lambs from crossbred ewes weighed 4.56 kg at birth and gained 7.63 kg during the first month, 6.16 kg during

the second, 8.30 kg during the third, 7.79 kg during the fourth and 7.57 kg during the fifth month. Lambs from purebred ewes weighed 4.28 kg and gained 6.35, 6.13, 7.55, 6.94, and 5.34 kg for the same periods of age.

The mean values of crossbred groups were compared to the mean values of purebred groups to test any significant differences. The crossbred ewes produced more milk and raised heavier lambs than did the purebred ewes.

Correlation between milk composition and growth rate of the lambs were found to be negative. Correlation between milk yield production and growth rate of the lambs were positive but not significant.

Conclusion

It can be concluded that the beneficial effects achieved by crossing Awassi rams to Chios ewes are:

An increase in the milk production at 70 days of the crossbred ewes.

An increase in the fertility and prolificacy for the crossbred ewes.

An increase in the growth rate of the crossbred lambs.

Recommendations

The crossbreeding and selection project was started to increase the meat and milk production of Awassi sheep in Lebanon. The growth rate of crossbred and purebred lambs have been analyzed along with milk production and are presented in this thesis study. However, a better study would be realized if milk is recorded and analyzed throughout the whole lactation period.

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APPENDIX

List of abbreviations

Word or Sentence	Abbreviation
calcium	Ca
difference	diff.
first	1st
fifth	5th
fourth	4th
gram(s)	g
hour	hr.
International Unit	I.U.
kilogram(s)	kg
milliliter(s)	ml
number	No.
ounce(s)	oz.
page(s)	p, pp
pound(s)	lb
second	2nd
solids-non fat	S.N.F.
third	3rd
weight	wt.