

Machine milkability as related to dairy yield and its fractions in dairy ewes⁽¹⁾

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Summary

The effects of breed, rearing method, udder conformation, udder consistency, lactation number and stage of lactation on milk yield and adaptation to machine milking were evaluated by determining milk yield fractions for Awassi and Assaf dairy ewes.

Although udder conformation for some ewes changed with lactation stage, differences in udder conformation significantly affected milk yield and adaptation to machine milking, while breed, rearing methods and udder consistency had non-significant effects. Adaptation to machine milking decreased with increasing age and stage of lactation. When selecting ewes for improved machine milkability, one should consider these relationships.

Introduction

Improvement in machine milkability, i.e., completeness of milk removal, and in milking efficiency, i.e., the number of ewes milked and the amount of milk obtained per man-hour, is of important economic benefit to dairy sheep farming. The goal of everyone associated with sheep milking is to achieve complete removal of milk by machine with little or no stripping.

Machine milkability of ewes, and efficiency of milking techniques, have often been measured by determining quantities and relative percentages of milk yields obtained by machine milking (prior to machine stripping), machine stripping, and hand stripping (EYAL, VOLCANI and SHARAV, 1958; GRUNFELD *et al.*, 1959; RICORDEAU *et al.*, 1963; BOSC, 1966; CASU, 1967; MIKUS, 1969; LABUSSIÈRE and RICORDEAU, 1970; MASAR, 1973; KASSALIJSKI and DIMOV, 1973; SHARAV, 1973).

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Selection for improved machine milkability by measuring milk yield fractions is a difficult and time consuming task, and is not practical under commercial farm conditions. The use of easily identified phenotypic traits closely related to effective machine milkability could be practical bases for selection. SAGI and MORAG (1974) showed a strong relationship between udder conformation in ewes and their milk yield, and milk yield fractions. Their exploratory studies were based on a single observation which did not allow measurement of effects due to age, stage of lactation or management variables. The studies reported here were designed to measure these interrelationships.

Procedures

This study was carried out with the same flock used by SAGI and MORAG (1974) which for this trial consisted of 229 Assaf and 40 Awassi ewes kept under the same management conditions. The flock was located at Neve Ya'ar, $32^{\circ}45'N$, $35^{\circ}12'E$ where the average day and night temperatures, respectively, were $34.0^{\circ}C$ and $19.8^{\circ}C$ in August and $17.6^{\circ}C$ and $7.8^{\circ}C$ in January, and the annual rainfall was 560 mm.

Lambs from 224 ewes were allowed to suck their dams for 15 to 30 min immediately after each milking to obtain milk not removed by thorough machine milking, machine stripping and hand stripping (i.e., complementary milk) which is the practice used in Israel as described by MORAG, RAZ and EYAL, 1970. Lambs were weaned from their dams when they reached 18 kg body weight. Ewes with twins or triplets were allowed to nurse only one lamb. The other lambs of the same litter were reared on ewe milk replacer as were lambs from 45 ewes who were weaned from their dams within one day *post partum*.

Data on milking performance was collected from twice daily milkings, every two weeks, from October 1972 to June 1973. The a.m. and p.m. milkings occurred after 16 and 8 hour intervals, respectively. Milking management was the same as described by SAGI and MORAG (1974). Yield per milking was divided into quantities obtained by machine milking (MM), by machine stripping (MS), and by hand stripping (HS), and the total was designated as the dairy yield (DY) as defined by MORAG *et al.* (1973). Adaptability to machine milking was determined by the amounts and percentages of these fractions.

Ewes were milked until dairy yield decreased below 300 g per day. Length of lactation was variable since no distinct lambing season was practised and many ewes lambed again before a previous lactation had been completed. Therefore, only data up to 130 days of lactation were analyzed.

Before each milking, the ewes' udders were classified into four types described

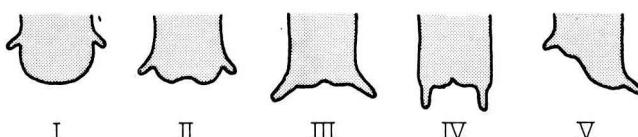


FIG. 1. — *Schematic representation of udder types.*
Représentation schématique des types de mamelle.

by SAGI and MORAG (1974), plus an additional type characterized by non-symmetrical udder halves (fig. 1). Udder consistency was determined by palpation to determine whether they contained hard tissue lumps as described by PLLOMMET (1973). In this respect, udders were classified as negative or positive, the latter without regard to the size of the lumps.

Data from the milk records were evaluated by least squares analysis (HARVEY, 1975) using the following statistical model:

$$y_{ijklmn} = \mu + a_i + b_j + c_k + d_l + f_m + g_n + e_{ijklmn};$$

y_{ijklmn} = milking parameter of any animal within subgroup;
 μ = overall mean;
 a_i = effect of i^{th} lactation number ($i = 1, 2, 3, 4, \geq 5$);
 b_j = effect of j^{th} udder type ($j = 1, 2, 3, 4, 5$);
 c_k = effect of k^{th} udder consistency ($k = 1$, negative; 2 , positive);
 d_l = effect of l^{th} breed ($l = 1$, Awassi; 2 , Assaf);
 f_m = effect of m^{th} rearing system ($m = 1$, suckling complementary milk;
 2 , early weaned);
 g_n = effect of n^{th} 10-day intervals of lactation stage ($n = 1, 2, \dots, 13$);
 e_{ijklmn} = sum of undefined effects (error term).

TABLE I

Effect of various traits on dairy yield and milk yield fractions in dairy ewes
Signification statistique des effets des paramètres anatomiques et physiologiques sur la quantité de lait trait et sur son fractionnement lors de la traite mécanique chez la brebis laitière

Trait	Lactation number	Udder type	Udder consistency	Breed	Rearing method	Stage of lactation		
<i>Variable :</i>								
			Analysis of variance ¹					
Dairy yield a.m..	***	***	***	*	NS	***		
Dairy yield p.m.	***	***	**	NS	NS	***		
Machine milk a.m..	***	***	***	NS	**	***		
Machine milk p.m.	***	***	NS	*	**	***		
Machine stripping a.m.. . . .	***	**	NS	NS	NS	***		
Machine stripping p.m. . . .	***	***	**	NS	NS	***		
Hand stripping a.m..	**	***	***	NS	*	***		
Hand stripping p.m..	***	***	***	NS	NS	***		
Machine milk a.m. (p. 100)	***	***	NS	NS	NS	***		
Machine milk p.m. (p. 100)	***	***	NS	*	**	***		
Machine stripping a.m. (p. 100)	***	***	NS	NS	NS	***		
Machine stripping p.m. (p. 100)	***	***	NS	NS	**	***		
Hand stripping a.m. (p. 100)	***	***	*	NS	NS	***		
Hand stripping p.m. (p. 100)	***	***	NS	**	NS	***		

(1) NS : not significant.

* : $p < .05$.

** : $p < .01$.

*** : $p < .001$.

Results and discussions

The result of the analysis of variance are shown in table I. Among the traits tested, udder type, lactation number and stage of lactation were the major causes of variation in dairy yield and its fractions.

As shown in figure 2, the differences between breeds for any milk fractions (expressed as a percentage of the dairy yield) ranged from 0.8 p. 100 for hand stripping at the 7 : 00 milking to 4.4 p. 100 for machine milk at the 15 : 00 milking and were not large enough to be of practical or statistical importance. The dairy yield of the Assaf breed was 114 g per day higher than for the Awassi breed

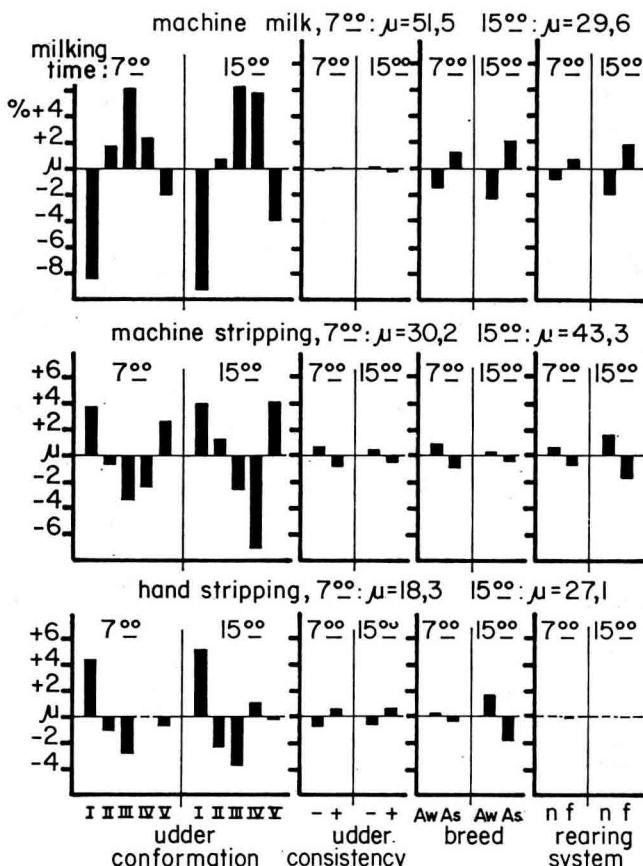


FIG. 2. — Percentage of milk fractions as influenced by udder conformation, udder consistency, breed, and rearing system.

Effets de la conformation de la mamelle, de la présence d'indurations intramammaires, de la race, et de la méthode d'élevage des agneaux sur l'importance relative des quantités de lait recueillies au cours des différentes phases de la traite.

— : no indurations Aw : Awassi n : suckling
+ : indurations As : Assaf f : early weaned

but this difference was not significant ($P > .05$). This may indicate that upgrading the Awassi by cross breeding with East Friesian Milchesheep to create the new Assaf breed did not substantially affect milkability or yield.

There were no differences of practical importance in milk yield fractions or dairy yield between ewes due to effects of the lamb rearing methods. Ewes rearing one lamb by having it suckle twice daily after milking had similar yield and milkability as ewes whose lambs were removed within one day *post partum*. This agrees with the findings by MORAG *et al.* (1970) and EVAL *et al.* (1972) of no negative effects on milk yield or milk ejection caused by allowing lambs to suckle after each milking. Since lambs were reared with complementary milk as the only liquid nourishment, this method of rearing can be highly recommended for the two Israeli breeds.

Udders with or without hard tissue lumps had similar percentages for milk yield fractions, however, those with lumps yielded 188 g more milk per day. PLLOMMET (1973) reported that lumps may result after infections of the udder by staphylococci and may contain inactive bacteria of that type. A possible explanation for the higher yield from ewes with udder tissue lumps could be that high yielding, previously infected ewes may be culled less frequently than low yielding previously infected ewes or that high yielding ewes are more susceptible to udder infections.

The relative amount of machine milk (MM) decreased and stripping milk (MS and HS) increased, with increasing lactation number (fig. 3). A similar effect was shown by JOHANSSON (1952) and WILKE (1960) who found slightly

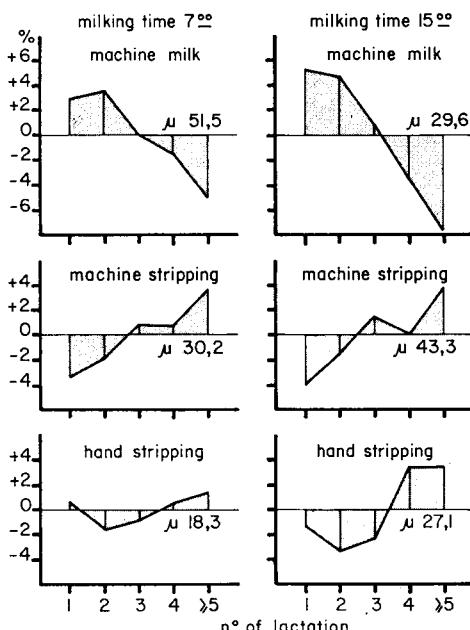


FIG. 3. — Effect of lactation number on the percentage of milk fractions.
Effet du nombre de lactations sur l'importance relative des quantités de lait recueillies au cours des différentes phases de la traite.

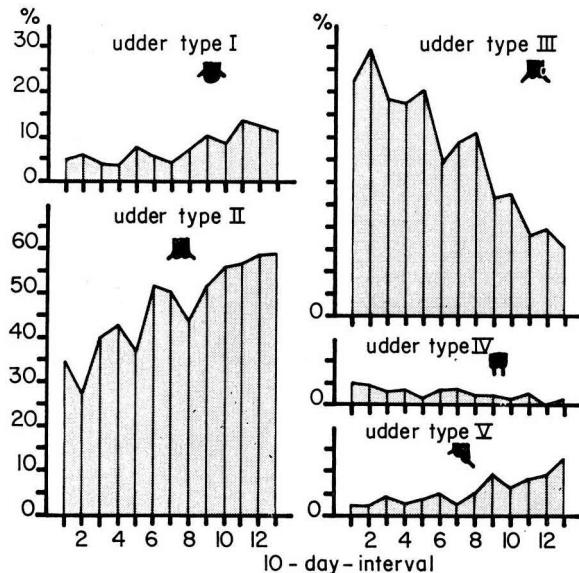


FIG. 4. — Distribution of udder types during the course of lactation.
Distribution des types de mamelle au cours de la lactation.

TABLE 2

Correlation coefficients between milk yield fractions at each of the two daily milkings, and the same variable on a daily basis

Coefficients de corrélation entre lait total et pourcentages de lait obtenus au cours des différentes phases de la traite à chacune des deux traitements quotidiens d'une part et les mêmes paramètres pour la production quotidienne

At each milking interval	On a daily basis			
	DY	MM	MS	HS
<i>16 h interval:</i>				
Dairy yield (DY) (kg)	0.98			
Machine milk (MM) (p. 100)		0.96		
Machine stripping (MS) (p. 100)			0.93	
Hand stripping (HS) (p. 100)				0.90
<i>8 h interval:</i>				
Dairy yield (DY) (kg)	0.91			
Machine milk (MM) (p. 100)		0.82		
Machine stripping (MS) (p. 100)			0.75	
Hand stripping (HS) (p. 100)				0.73

All correlations are significant ($P < .001$).

better milkability in cows during the first lactation compared to later lactations. On the other hand, Bosc (1966) found in Lacaune ewes that both the absolute and relative quantities of milk obtained by stripping were higher in the first lactation.

Ewes with type III udders had the best distribution of milk yield fractions with machine milk being 57 p. 100 and 36 p. 100 of the dairy yield at the a.m. and p.m. milkings, respectively (fig. 2). Under the same condition, ewes with

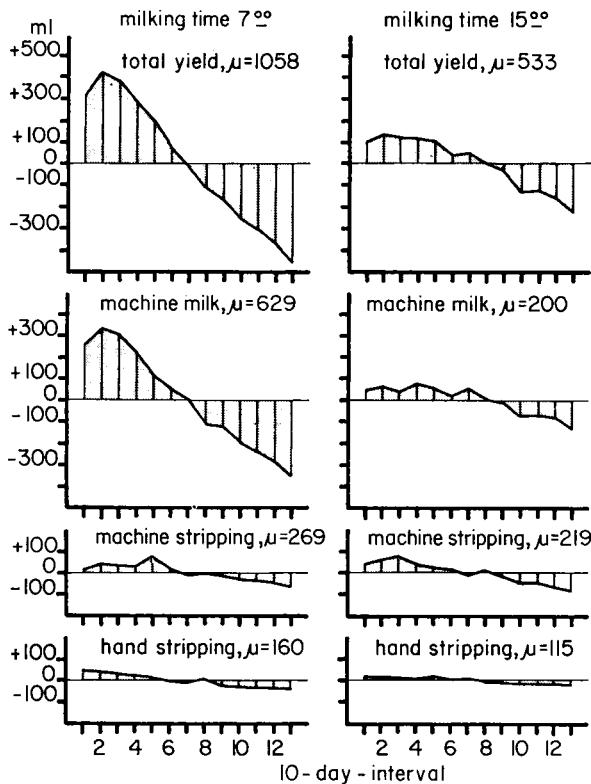


FIG. 5. — *Effect of stage of lactation on the amounts of dairy yield and milk fractions.*

Effet du stade de lactation sur la production totale de lait et sur les quantités de lait recueillies au cours des différentes phases de la traite.

type I udders gave only 43 p. 100 and 21 p. 100 of their dairy yields as machine milk.

There were no significant differences in average dairy yield between udder types II and III (1,747 and 1,741 ml/day, respectively) nor among udder types I, IV and V (1,462, 1,509, and 1,494 ml/day, respectively). However, the average yields of ewes with udder types II and III were significantly different ($P < .05$) from those with udder types I, IV and V. The latter three udder types represented only 17 p. 100 of all observations.

These relationships between udder type, dairy yield and milk yield fractions,

although not as dramatic as in the earlier investigation, would be of great value to the improvement of dairy sheep if udder type was persistent throughout lactation. Unfortunately, this is not the case. As shown in figure 4, the frequencies of udder types I, II and V tend to increase during the course of lactation whereas udder types III and IV are more frequent in early lactation. Since "udder type" is not persistent throughout lactation, selection for this trait cannot be carried out effectively without considering the stage of lactation. Therefore, the exclusive preference of udders of types III and IV, as suggested by SAGI and MORAG (1974), cannot be recommended. However, ewes with damaged udders (type V) and those with a bad suspensory apparatus (type I) should be culled not only because of poor milkability but because teat cups tend to fall off during milking.

The lactation curve of dairy yield from ewes, shown in figure 5, resembles a cow's lactation curve. Peak yield occurred at the end of the second 10-day interval. The curve for dairy yield at the p.m. milking after an 8-hours interval declines less steeply than that for the a.m. milking after a 16-hours interval. The slope of the curve for dairy yield and machine milk fractions are almost identical whereas absolute amounts of stripplings decline very slowly and almost linearly in accordance with MASAR's results (1974).

TABLE 3

Correlation coefficients between the absolute and relative milk fractions at each of the daily milkings and the total daily yield
Coefficients de corrélation entre le lait total quotidien et les quantités et pourcentages du lait obtenus au cours des différentes phases de la traite (traite du matin: 16 h d'intervalle, traite du soir: 8 h d'intervalle)

Milk yield fractions each milking interval	Daily dairy yield
<i>16 h interval:</i>	
Machine milk (ml)	0.89
Machine stripping (ml)	0.45
Hand stripping (ml)	0.43
Machine milk (p. 100)	0.46
Machine stripping (p. 100)	— 0.34
Hand stripping (p. 100)	— 0.39
<i>8 h interval:</i>	
Machine milk (ml)	0.70
Machine stripping (ml)	0.63
Hand stripping (ml)	0.40
Machine milk (p. 100)	0.40
Machine stripping (p. 100)	— 0.16
Hand stripping (p. 100)	— 0.43
All correlations are significant ($P < .001$).	

It would be interesting to know if recording milk yield fractions only once a day would be representative and reliable for selection purposes. Correlation coefficients, given in table 2, between daily parameters and those measured after 16 hours and 8 hours intervals, are very high. However, the recordings made after the longer interval were the ones most highly correlated with daily values.

Correlations between daily dairy yield and milk yield fractions in absolute and relative terms, given in table 3, indicate that high yielding ewes are better milkers as well. This is an accordance with MASAR (1976). In addition the amount of machine milk fraction after the long milking interval is correlated with the percentage of daily machine milk ($r = + 0.72$), with the percentage of daily machine stripping ($r = - 0.58$) and with the percentage of daily hand stripping ($r = - 0.56$); all the correlations were significant ($P < .001$). Thus, the amount of machine milk fraction seems to be a parameter that should be tested for its genetic value as a selection parameter since it is easy to measure and can be used whether or not simplified milking methods are used in the flock.

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Résumé

Influence de l'adaptabilité à la traite mécanique sur le rendement en lait et ses composantes chez les brebis laitières

Les effets de la race, de la méthode d'élevage, de la conformation de la mamelle, de la présence d'indurations intramammaires, du nombre de lactations et du stade de lactation sur la quantité de lait et sur l'adaptation à la traite mécanique sont évalués sur la base des différentes fractions de lait recueillies lors de la traite mécanique de brebis laitières de race Awassi et Assaf.

La quantité totale de lait et l'adaptation à la traite mécanique sont affectées significativement par la conformation de la mamelle; par contre, la race, la méthode d'élevage et la consistance de la mamelle ne sont pas sources de variance significative. La conformation de la mamelle définie selon 5 types caractéristiques varie au cours de la lactation. L'adaptation à la traite mécanique diminue avec l'âge de l'animal et le stade de lactation. Ces observations doivent être prises en considération pour améliorer les critères de sélection des brebis laitières destinées à être soumises à la traite mécanique.

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