SEMI-ANNUAL PROGRESS REPORT

6th 6 Months (April, 2003 - September, 2003)

PROJECT NO.: PCE-G-00-00-00029-00

PROJECT TITLE: MULTINATIONAL APPROACHES TO ENHANCE GOAT PRODUCTION IN THE MIDDLE EAST

I. Technical Progress

I.A) Research Objectives

1) Determine chemical and bacteriological status of goat milk in the Middle East (Israel, Jordan, and Egypt)
2) Determine effects of subclinical intramammary infection on milk quality (Israel)
3) Transfer milk processing technologies (e.g., improvements in milk storage quality and introduction of new milk products) to goat farmers in the Middle East (Jordan, Egypt)
4) Characterize goat production systems and practices in the Middle East (Jordan and Egypt)
5) Characterize goat disease conditions in the Middle East (Jordan)
6) Introducing new technologies able to improve utilization of feed resources in the region either by increasing their nutritive value, conservation to critical times, or compressing it to be easy transferable (Egypt)
7) Improving goat productivity in areas of the northern Sinai of Egypt that do not have access to Damascus goats by distributing bucks or by using artificial insemination (Egypt)
8) Enhance local extension capabilities by technical training (Egypt)
9) Expanding project achievements through seminars and field days with Bedouins in the northern Sinai region (Egypt)

I.B) Research Accomplishments

JORDAN

Goat milk product studies and workshops

Previously, milk was collected, analyzed for chemical constituents, and the microbiological status was investigated. We continued milk collection from the Ajloun area to manufacture cheddar and white cheeses. They were evaluated for chemical composition, microbiological load, and sensory characteristics. These data appear in APPENDICES A and B.

Traditional milk products such as yoghurt, labanh, jameed, kishk, butter, and ghee were produced in the lab. Some improvements were introduced to the method of production such as producing jameed in small size (1cm^3 in size). To transfer the knowledge of heat treatment and

cheddar cheese production from goat milk to goat farmers, a workshop was held in the Ajloun area during the period of September 29-30, 2003. Farmers learned the necessary steps for cheddar and traditional white cheese manufacturing, to make them learn the effect of temperature (pasteurization), which was discussed in detail. Some twenty thermometers were donated to farmers along with some annatto cheese dying materials to encourage farmers to produce cheddar instead of tradition white cheese ($ 2.8 per kg), since cheddar cheese is sold in Jordan at $ 45 per kg. A draft of a manuscript concerning milk characterization work in Jordan is given in APPENDIX B.

Extension activities

We continued collecting data as required by the questionnaire, which was distributed to goat farmers in the Ajloun, Bani Kinanh, and Jarash areas. The collected data covered a wide range of information of the goat farming industry in Jordan. Questions have been asked to collect descriptive data on farming systems, demographic status, goat breeds, land, grazing, feed, animal health, types of products, milk yield, marketing, traditional products, use of available technology, animal care, management, record keeping, diseases and vaccination, extension services, etc.

Data collection is still in progress. Some of the collected data were statistically analyzed, particularly data from the Ajloun and Bani Kananh areas. Those data where presented and discussed in a project meeting in Cyprus meeting in October, 2003.

Some statistically available data are presented in Tables numbered from 1-30 in APPENDIX A. The generated data were presented and discussed with farmers in the Ajloun area during the period of 29-30 September, 2003. The feedback was considered and some farmers showed enthusiasm toward developing their abilities to enhance their production. Also, goat farmers found that workshops are beneficial and encouraging. Our data showed a clear picture of the goat farming industry in Jordan. For example, no clear goat farming system could be identified; only the open farming system prevails in the investigated areas. Goat farmers in the investigated areas were found to be old (over 61 year old) with no education (a poor people industry).

Tables numbered as Extension, 1-30, in APPENDIX A show age, educational level, experience of farmers in goat industry, full-time, part-time farming, house hold income from goat, record keeping, family member responsibility toward grazing, feeding, watering, milking, medical treatments, and miscellaneous farm work, goat theater, and livestock property. The team led by the extension leader are working on the statistical analyses for the rest of the tables, which will provide much additional valuable information.

Goat health:

For an effective disease control program, it is so important to have a record of common diseases prevalent in an area. Slaughter houses provide excellent opportunities for detecting diseases of both economic and public health importance. Accordingly, we have survey the disease prevalent in goats in Northern Jordan. Slaughter houses were visited between November 2002 and September 2003; data were collected on the pathological conditions found in the slaughter houses. Post-mortem examination was done by visual inspection and palpation and by

incision of suspected organs. Specimens from affected organs were collected for further laboratory investigation.

A total of 1,432 goats were physically examined in the slaughter houses, of which 79% were males and 21% were females. Table 1 in APPENDIX A represents the disease conditions and their percentage incidence.

ISRAEL

Research discussed in the previous 6-month report was continued in this 6 months. This research consisted of performing tests on bacteriological status and milk composition and yield, based on the glandular level. A goatherd of around 80 milking does was examined through two lactation periods but results. However, results have not yet been fully analyzed and will be presented in the next report. Partial examination of 150 does in their first lactation was performed and is pending future financial funding.

Scientific background

In Israeli dairy goat herds, various species of coagulase-negative staphylococci (CNS), mainly *Staphylococcus caprae* and *Staphylococcus epidermidis*, formed the main pathogen group in infected udder halves. In addition, milk yield was significantly higher in uninfected than in infected halves. However, a direct comparison between infected and uninfected gland was not possible because the measurements were based on the whole udder level and not on a single-gland level. Therefore, a model based on a glandular level, where each animal had one udder-half infected with identified CNS specie and the contra-lateral gland being free of bacteria, was developed in order to focus insight on how subclinial mastitis affects milk yield and compositional changes in relation to curd yield. Subclinical intramammary infection (IMI) is associated with increased plasminogen activator (PA) and plasmin (PL) activities as a result of accelerated conversion of plasminogen (PLG) to PL in the infected glands. These changes are associated with accelerated apparent casein (CN) degradation, reduced curd yield, and increased milk clotting time. These modifications indicate that the changes in milk composition negatively affect cheese yield and cheese quality made from milk originating from infected glands.

PL is the main proteolytic enzyme in cow and sheep milk, where it is found mostly as the inactive zymogen PLG, which is activated by PA. However, only residual PLG activity was found in goats, consistent with an unusual high PA activity in comparison to the values found in ovine and bovine. Nevertheless, PA and PL activities in late lactating goats were negatively correlated with the coagulating properties of milk, suggesting that this system is important in goats as well.

The present study used the glandular level model in dairy goats testing to effects on milk yield and milk quality as reflected in curd yield and coagulation time. In order to achieve this goal, animals chosen had one udder half infected with identified CNS species and the contra-lateral gland was free of bacteria. In each gland we analyzed inflammation indices, total milk protein, CN, whey proteins and the PA-PL system activity, and measures of proteolysis.

Methodology

The methodology used in the present term was similar to that reported in the last semi-annual report of April 2003, and thus will not be repeated. However, the present study concentrated on a small number of individual goats.

Animals

Twenty-five Israeli dairy goats representing various crossbreds mainly Shami x Anglo Nubian and Saanen x Anglo Nubian, in which one udder half was infected with a single specie of CNS and the contra-lateral gland was bacteria-free, were selected from two flocks. Milk samples from each udder-half were tested for bacterial infection, somatic cell count (SCC), and N-acetyl-glucoseaminase (*NAGase*) activity by three consecutive weekly examinations. The selected goats were 40 to 120 days after kidding and their daily milk yield exceeded 2.5 L. In both farms the goats were milked twice daily with post-teat dipping at 5 AM and 3 PM. They were kept in an open shelter providing 4 m^2 of shaded slatted floor and 4 m^2 of a concrete surface yard for each goat. Food was offered in mangers located in the sheds.

Milk sampling and analysis

The measurement of milk yield and sampling procedures were carried out during the morning milking. Yield was determined by weighing the milk of each udder half of all the goats individually after hand milking. For the bacteriological tests and *NAGase* activity, halves were cleaned, disinfected, sampled, and analyzed. Three additional sets of samples were taken from each udder half and distributed for analysis as follows: One set was preserved with Broad Spectrum Microtabs® II (D & F Control Systems, Inc., CA) and was sent to a central laboratory (Cattle Breeders Association Laboratory, Caesarea, Israel) for analysis of milk gross composition: protein, fat, and lactose using the 6000 Milkoscan and SCC with a Fossomatic 360 (Foss Electric, Hillerød, Denmark), both calibrated with goat milk. The second set of the samples was used to determine curd yield (Yc) and clotting time (Tc). Curd yield was determined after drying using Fromase 15 TL (Gist-Brocades nv, Delft, Holland) as the coagulating enzyme. In order to determine the accuracy of the curd yield measurement, tests were performed consisting of determining Yc on dry and wet bases of the same sample. The testing of dry curd was altered to suit the modification of the present procedure. It consisted of weighing the wet curd after centrifugation and continuing with drying of the curd overnight in an oven at 100°C. This was done without transferring the curd sample to another container for drying, but rather leaving it in the centrifugation tube to prevent any possible loss of curd during transfer of the centrifuged curd pellet. The correlation between curd yields based on wet curd yield vs. dry curd yield is presented in Figure 1, with a regression coefficient of 0.96. Clotting time was measured as described previously.

A third set of the milk sample was defatted and the skim milk was used for the analyses of the concentration of casein, whey proteins, albumin, proteose peptones (p-p), and activity of PA, PLG, and PL. The concentrations of free (ionized) calcium ($[Ca^{2+}]$) by the repeated addition procedure and calcium activity (a_{Ca}^{2+}) by the uncorrected procedure were determined in these samples within 5 h from sampling using a specific calcium electrode.

Bacteriological examinations

Bacteriological analysis was performed according to accepted standards. From every milk sample, 0.01 ml was spread onto blood-agar plates (Bacto-Agar; Difco Laboratory) containing 5% of washed sheep red blood cells and on MacConkey plates. All plates were incubated at 37°C and examined for growth after 18 and 42 h. Colonies suspected to be staphylococci were tested for coagulase (tube test) (Anilab, Rehovot, Israel). Strain identification was carried out with the API STAPH-IDENT, 32 Staph kit (bioMerieux S.A., 69280 Marcy-l'Etoile, France). When the percentage of micrococci-like bacteria that matched the test strain exceeded 90%, the strain was regarded as specific.

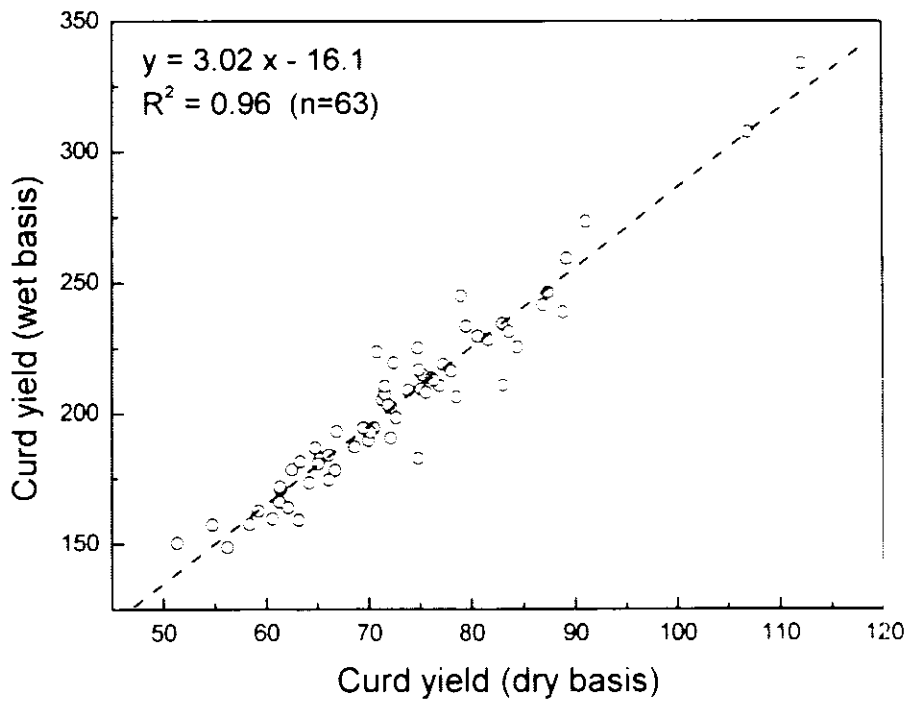

Figure 1. Comparison of curd yield on dry basis vs. wet basis (g L).

Statistical analysis

Data were analyzed with the SAS User's Guide: Statistics, Software Release 8.2 (SAS Inst., Inc., Cary, NC, 2002). Dependent variables were SCC and Log SCC, *NAGase*, milk, fat, protein, lactose, CN, whey proteins, albumin, p-p, $[Ca^{2+}]$, $a_{Ca^{2+}}$, PA, PLG, PL, curd, and Tc. Calculations were performed for ratios of CN/total protein, whey proteins total protein, and PLG/PL and Yc. The independent variables, bacteriological status and goat, were examined according to the model:

$$Y_{ij} = u + G_i + B_j + e_{ij}$$

where: Y_{ij} = dependent variable; u = overall mean; G_i - goat 1...25; B_j = bacteriological status i = 1 (infected) or, 2 (uninfected); e_{ij} = error term.

No significant difference was found between analyses based on SCC and those based on Log SCC; therefore, the results presented are those based on the arithmetic SCC.

Results

Various species of CNS: *S. epidermidis*, (11), *S. simulans* (6), *S. caprae* (2), *S. chromogenes* (3), and *S. xylosus* (3) were the pathogens that caused udder infections. No clinical abnormalities were visible or could be felt in more than 80% of the goats tested. Due to the small number of each specie and previous results on a large data set, all the CNS species induced an increase of SCC to ~ 10^6 cells/ml.

Milk yield of the infected halves (0.69 kg/milking) was significantly lower ($P < 0.0001$) than that of the uninfected halves (0.98 kg/milking) (Table 1). The measurements of infection response, SCC and *NAGase* activity, were significantly higher in the infected halves than in the uninfected ones.

Table 1. Mean and SE of bacteriological status vs. the different independent variables and its effects of 25 Israeli dairy goats over sampling (tested 3 times).

Parameter	Bacteriological Status		Effect	
	Uninfected	Infected	Infection	goat
Milk (kg/milking)	0.98±0.04	0.69±0.04	< 0.0001	< 0.0001
SCC ± SE (x 1000)	417±72	1750±197	< 0.0001	0.07
Log SCC				
NAGase	13.6±2.7	37.9±4.5	0.05	NS
Fat (g/L)	38.9±1.1	38.8±1.2	NS	0.0002
Protein (g/L)	34.2±0.5	35.0±0.5	0.07	< 0.0001
Lactose (g/L)	47.0±1.0	41.7±1.3	0.004	0.004
Whey (g/L)	6.1±0.3	6.8±0.4	< 0.0001	< 0.0001
Casein (mg/ml)	28.1±0.7	28.2±0.8	NS	< 0.0001
Albumin (μg/ml)	279.7±22.2	471.8±49.8	0.003	0.04

Lactose concentration in the uninfected glands was significantly higher (47.0 vs. 41.7 g/L, $P < 0.004$) than in the infected ones. The concentration of fat did not differ between the uninfected and infected halves (38.9 vs. 38.8 g/L). Protein concentration tended to be lower in the uninfected glands (34.2 vs. 35.0 g/L; $P < 0.07$). Casein concentration did not differ (28 g/L), while whey protein concentration was significantly higher in the infected glands (6.1 g/L in the uninfected vs. 6.8 g/Lin the infected) and albumin concentration was significantly lower in the uninfected glands than in the infected ones (279.7 vs. 471.8 μg/ml; (Table 1). The goat effects on these variables were significant (Table 1).

The PA and PL activities were significantly higher in the infected glands than in the uninfected ones (Table 2). PLG activity was very low to undetectable, and therefore data on PLG were not presented. Concentrations of $[Ca^{2+}]$ did not differ, whereas $a_{Ca^{2+}}$ was significantly

lower ($P < 0.002$) and p-p concentration was almost 2-fold higher ($P < 0.0005$) in the infected glands than in the uninfected ones (Table 2). Goat effects were significant for $a_{Ca^{2+}}$ and p-p and insignificant for $[Ca^{2+}]$.

Curd yield was significantly lower ($P < 0.0001$) in the uninfected ones (231.6 vs. 207.8 g/L, respectively) with a significant goat effect ($P < 0.0001$). Clotting time was significantly longer ($P < 0.02$) in the infected halves than in the uninfected ones: 295 vs. 167 sec, respectively ($P < 0.02$), with a relatively low goat effect ($P < 0.08$) (Figure 2).

Table 2. Means ± SE of plasmin (PL), plasminogen activator (PA), calcium activity ($a_{Ca^{2+}}$), free (ionized) calcium ($[Ca^{2+}]$), proteose peptones (p-p), curd yield (Yc), clotting time (Tc) and its effects.

Parameter	Bacteriological Status		Effect	
	Uninfected	Infected	Infection	Goat
PL (unit/ml)	20.32±2.4	39.81±6.1	0.0003	0.005
PA (unit/l)	3376±404.1	4334±565.5	0.05	0.002
$a_{Ca^{2+}}$ (mmol)	1.89±0.1	1.62±0.1	0.002	< 0.0001
$[Ca^{2+}]$(mmol)	4.80±0.4	5.05±0.3	NS	NS
p-p (mg/ml)	0.35±0.05	0.53±0.05	0.0005	0.0002
Yc (g/L)	231.6±2.9	207.8±2.7	<0.0001	<0.0001
Tc (sec)	167±18.6	295±43.4	<0.02	<0.08

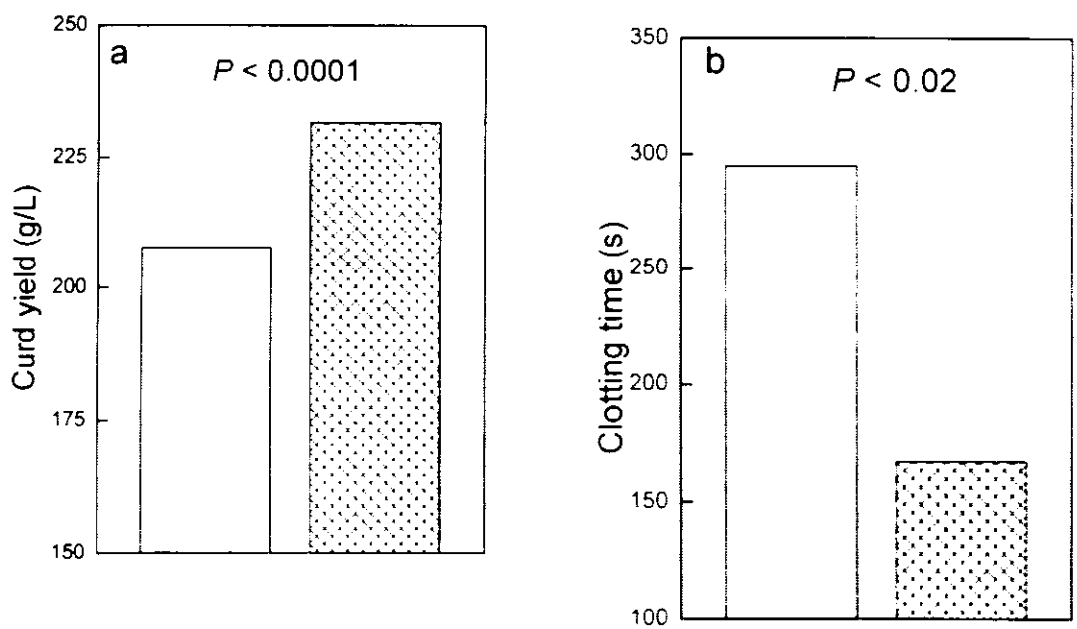

Figure 2. Effect of subclinical mastitis on curd yield, Yc (a) and clotting time, Tc (b), in milk of infected vs. uninfected udder halves.

Discussion

The model and individual animal effect

This study, consistent with a recent study on sheep, has shown that the half-udder as the experimental unit enables the quantification of the negative effect of subclinical mastitis on milk yield with high statistical reliability on a relatively small data set of 20 to 40 animals. The half-udder model provides an effective tool to isolate the experimental effect from confounding effects. An alternative approach based on conventional whole udder sampling would require a data set in the range of 100 animals in order to account for the large and significant individual variation in sheep or goat effects on most indices measured in these studies. These significant sheep or goats effects most likely reflect the diversity of genetic (breed) sources in the Israeli flocks and are perplexed further by effects such as farm management, environmental conditions, age, and stage of lactation. Obviously, all the above factors are counterbalanced when the unit of comparison is the two udders of the same animal.

When the comparison variable is milk yield, it should be taken into consideration that compensation of milk yield in the uninfected gland was found in sheep and goats. Thus, in sheep the effect of subclinical mastitis on the whole animal level is significant if both glands are infected. Nevertheless, in sheep and goats, milk composition in the uninfected gland was not altered by this compensation; therefore, the comparison between the infected and uninfected glands reflects directly the effect of IMI.

Infection and milk yield

CNS bacteria, mainly *S. epidermidis*, *S. simulans*, and *S. caprae*, are the most abundant bacterial isolates that are associated with subclinical mastitis in goat flocks in various countries. CNSs are not considered pathogenic bacteria and their infection is usually ignored by farmers and veterinarians. Nevertheless, CNS infection induces an inflammatory response, which is reflected by high SCC consistent with previous findings in goats and sheep. The inflammatory response was associated with a marked reduction in milk yield in the infected gland in comparison to the uninfected one, consistent with earlier results in goats and sheep. In sheep, when one gland is infected, the contra-lateral gland compensates for about 80% of the reduced milk yield. On the other hand, when both glands are infected, milk yield losses are severe. The current practice, in which relatively little effort is invested in preventing bacterial infection in dairy goat herds in most countries, will have to change if milk will start to be graded according to SCC and farmers will be made to pay penalties for low-quality milk.

Calcium activity (a_{Ca}^{2+}) as a measure of casein degradation

A negative linear relationship between CN concentrations in the milk of humans, goats, cows, sheep, and mice, on the one hand, and a_{Ca}^{2+} on the other, have been demonstrated, a finding which is consistent with the fact that CNs are powerful Ca chelators. In the present study, a_{Ca}^{2+} was negatively related to measures of proteolysis (p-p), consistent with results in sheep. The association between CN degradation and the reduction in a_{Ca}^{2+} may be related to the exposure of phosphoserine groups that are hidden within the casein micelles, because these molecules are responsible for the Ca-chelating properties of CN. Casein degradation occurs in the gland during the intervals between milkings. Thus, the differences in a_{Ca}^{2+} between the infected and uninfected glands represent the additional CN degradation in the infected glands.

The present results support further the conclusion that measurement of a_{Ca}^{2+}, which is rapid and cheap, appears to be a valuable tool to monitor the extent of CN degradation under various conditions.

Curd yield and milk clotting time

The present study on the determination of curd yield based on dry matter in comparison to our modification as presented earlier, shows that both methods result in good approximation (Figure 1). However, the tedious procedure of transferring the pelleted curd from the centrifuge tube to the dry matter-weighing dish could not be disregarded. Thus, drying the pellet in the same tube without disturbing the curd results in lower deviation, which should be considered in cases where very limited differences occur. The conversion of casein to whey components (p-p) by PL could partially explain the reduction in curd yield. In addition, a positive significant correlation was observed between both PL and PA activities on the one hand, and rennet clotting time on the other, is consistent with similar interactions found in late-lactating goats and in subclinically infected sheep.

Curd yield was lower in the infected halves than in the uninfected ones despite almost equal CN content in both glands. Thus, our data suggest that knowing the gross CN content in the milk is insufficient for predicting curd yield, probably because of modifications in the CN micelles or in the different casein micelle's components that are more detrimental to curd formation than CN concentration by itself. The changes in p-p and a_{Ca}^{2+} in the infected glands suggest that CN was modified due to the release of certain peptides from the CN or a change in the casein micelle compaction due to changes in $[Ca^{2+}]$ and a_{Ca}^{2+}.

The primary enzymatic coagulation is based on the action of rennin on κ-casein, which thereafter reveals hydrophobic sites on the casein micelle making it available for the secondary aggregation reaction. Thus, certain enzymatic hydrolysis of κ-casein may occur with a much more pronounced hydrolysis of the other caseins, which thereafter interfere with the coagulation process.

The increase in clotting time of milk coming from infected glands found in sheep and in the present study could be due to the increased PL activity, as was reported for added PL to bovine milk. It is suggested that the long milking interval of about 12 h before the morning milking results in considerable proteolysis of caseins by PL due to its accumulation for that long period.

Interrelationships between milk yield and composition in subclinically mastitic goats

In general, two types of compositional responses were recorded in subclinically mastitic goats and sheep:

1. Reduction in milk yield in the infected glands in goats and sheep, being lower than the reduction in the secretion of protein and fat. Consequently, protein and fat concentrations are higher in infected glands than in uninfected ones. This response was related to mild increase in plasmin activity (30 to 50%) over the basal level. Under such conditions, plasmin-induced hydrolysis of CN liberates a peptide from β-CN (β-CN 1-28), which in turn down-regulates milk secretion in cows and goats: its activity was correlated with its ability to block potassium channels in the apical membranes of mammary epithelia.
2. Reduction in the secretion of protein and fat being higher than the reduction in milk yield. Consequently, the reduction in milk yield is associated with reduced fat and protein

concentration. Such a response was observed when the increase in PL activity is high (twice or more), as is the case during milk stasis or inflammation. It has been shown that CN hydrolysis under high PL activity induces rapid drying-off of mammary secretions in goats and cows.

3. In the present study, the reduction in milk yield matched more or less the reduction in protein and fat secretion, so that the total net effect was no change in protein and fat concentration. However, as discussed above, there is compelling evidence that CN was degraded and modified in the infected gland. The marked reduction in lactose concentration resembles the response in sheep and cows under high PL activity. Thus, the degree of PL activation dictates not only the reduction of milk volume, but also the changes in the secretion of organic components and, consequently, milk composition and curd yield, probably due to certain structural modification in the molecule ability to aggregate owing to the proteolytic action of enzymes on the casein micelle.

Comparative aspects between goats and sheep

In a recent study in sheep, we found that milk yield in the infected glands was about 50% lower than in the uninfected glands, which is essentially similar to the percent reduction in milk yield in the infected glands in the present study. Thus, the fact that we used the half-gland model and the same set of measurements, using the same methodologies in both studies, provides us with a unique opportunity for performing a comparative species response to subclinical IMI with CNS.

The levels of SCC in uninfected glands of goats and sheep (around 200,000 cell/mL) are higher than those reported for uninfected cows. In both goats and sheep, CNS IMI increased SCC to above 10^6 cells/ml, which suggest that diapedesis in response to CNS IMI in goats and sheep is more acute than in cows. Whether this more acute influx of leucocytes to the mammary gland is associated with improved antibacterial defense capacity is a matter that remains to be solved.

In goats and sheep, the reduction in whey protein secretion was lower then the reduction in milk yield, with the outcome of increased concentration in the infected glands in the two species. The gross CN concentration in goat's milk (28 g/L) resembles that of cows and is much lower then in sheep (40-46 g/L). Thus, both p-p concentration in uninfected glands in goats and the increase of p-p in response to doubled PL activity in the infected gland were much lower than the corresponding figures in sheep. The higher PL activity in uninfected glands in sheep in comparison to goats was an additional factor that probably contributed to the higher level of p-p in uninfected glands of sheep.

When the activity of PLG is added to PL (i.e., total-derived PA activity) it becomes clear that this value is considerably higher in sheep compared to goats. In addition to the presumed high conversion of PLG to PL due to the high PA activity, the initial level of the PLG pool in the gland ought to be much lower than in sheep. This may be an additional contributor to the apparent rapid disappearance of PLG in the mammary glands of goats.

It has been suggested that regulation of PA activity serves as a bridge between systemic hormonal influences and the local regulatory system. In mice mammary gland organ culture, hormones that fostered involution induced the synthesis of PA, while hormones that promoted lactation repressed the secretion of PA. The treatments of cows and sheep with bovine-somatotrophin increased milk yield and reduced the conversion of PLG to PL. On the other

hand, stress, stress hormones and estrogen, which induce down-regulation of milk yield, increased PL activity in milk. The high basal level of PA in goats may make the system irresponsive to systemic effects. In line with this proposition, treating goats with somatotrophin did not affect the PA system, whereas treating goats with adrenocorticotrophin and dexamethasone did not reduce milk yield, as is the case with dairy cows.

Extension and publications

During the period of the present report, the Israeli investigators have visited several goat farms in order to conduct the experimental work and transfer the bacteriological findings to the farmer and his veterinarian.

Several one-day seminars were held and data were disseminated to the Extension personnel, who are in daily contacts with the farmers. The principal investigator was involved in a course on "Goat milk products and cheeses" held by the Ministry of Agriculture, aimed on training farmers in obtaining capabilities to produce quality dairy goats products. Subjects covered included: milk quality and composition, milk yield and feeding, cleaning and disinfecting dairy equipment, pasteurization and technological aspects of goat milk, fermented milk products, cheese making practices, etc.

A research paper entitled: ***"Effect of subclinical intramammary infection on somatic cell counts, NAGase activity, and gross composition of goat's milk"*** was accepted for publication in the *Journal of Dairy Research (APPENDIX C)*.

EGYPT

Characterization of goat production systems in North Sinai

This activity has been attained through use of a questionnaire forwarded to 243 Bedouins, representing different locations, and a follow-up study including 18 farms representing the three production systems identified in the region. The questionnaire activity has been completed, data have been analyzed, and a manuscript has been prepared. The follow-up study is underway. The 18 farms continue to be visited. Visits to each flock have been concentrated (bi-weekly) during July, August, and September since this is the period of kidding, and monthly visits occur at other times. Two personnel teams are responsible for the visits. Medical care has been offered to the flocks under study.

Technology transfer

At time of reporting, a large number of Bedouins were added in order to increase the benefit from the transfer packages. There are 5 farms where treating available barley straw with urea and molasses has been demonstrated. Treating corn stalks with urea and molasses has been demonstrated at 2 farms. On 11 farms feed block processing has been demonstrated. For this activity, farmers received support through supply of some of the feed ingredients used in making the blocks (e.g., soybean meal, date stone, Olive cake and some vitamins and minerals).

Improving goat productivity

The plan of genetic improvement of goats was modified slightly based on results of the questionnaire. The target breed for improving goats is found in the region (i.e., Damascus). The number of Damascus goats increases as proximity to the Israeli border decreases. The

contribution of the Damascus genotype to flock genetics relates to the socioeconomic status of Bedouin farmers and feed availability. Providing Bedouins in isolated areas with Damascus bucks will help them in genetically improving their flocks. Therefore, 25 local Damascus bucks were purchased and loaned to Bedouins (23 beneficiaries) during the mating season of June and July, 2003

Identifying the hygienic status of goat milk in the region

Milk samples were collected monthly for three months from 12 flocks. Milk composition was determined. A Masters degree student (Marwa Hatem) carried out her research on the bacteriological status of milk through this project. Some of these data are shown below.

Project publications

Pamphlets on most packages, developed and introduced to the area, were prepared. They addressed the areas of fattening kids, making silage, treating with urea, and processing feed blocks.

Establishing supporting facilities in the region

A Bacteriology Laboratory has been established in the Central Agriculture Department for direct and fast analysis of milk samples. The Laboratory is equipped with an oven, incubator, and microscope. An additional adjacent room was prepared for sample preparation and storage.

Table (1) : Milk composition of colostrums, early, mid and late lactation samples in the extensive production system of North Sinai.

Lactation stage	N	Fat %±SE	Protein % ±SE	Lactose % ±SE	Ash % ±SE	Total solids% ±SE	Acidity % ±SE	PH value ± SE
Milk colostrum	6	4.42 ±0.04	5.18 ± 0.04	2.15±0.03	0.96±0.03	12.43±0 16	0.22±0 006	6 4±0 002
Early- lactation	25	4.24±0. 09	3.2±0.04	3.14±0.02	0.75±0.01	11.57±0.09	0 15±0.002	6 65±0 01
Mid-lactation	20	3.77±0.02	3.12± 0.01	3.32 ±0.006	0.69±0.007	10.84± 0.04	0 15±0.001	6 63±0 004
Late lactation	13	4.09±0.02	2.21±0.01	3.25±0.008	0.83± 0.006	10.49±0.11	0.16±0	6.42±0.01

Table (2) : Milk composition of colostrums, early, mid and late lactation samples in the semi-intensive production system of North Sinai.

Lactation stage	N	Fat %	Protein %	Lactose %	Ash%	Total solids%	Acidity %	PH value
Milk colostrum	2	4.55	5.12	2.13	0.92	12.23	0.21	6.4
Early lactation	4	3.8	3.24	3.1	0.72	11.25	0.16	6.63
Mid-lactation	5	3.88	3.21	3.3	0.67	10.69	0.16	6.64
Late lactation	4	4.2	2.22	3.27	0.87	10.04	0.16	6.32

Table (3) : Milk composition of colostrum, early, mid and late lactation samples in the intensive production system of North Sainai.

Lactation stage	N	Fat %	Protein%	Lactose%	Ash%	Total solids%	Acidity%	PH value
Milk colostrums	3	4.03	5.01	2.25	1.0	12.37	0.22	6.42
Early lactation	18	4.12	3.3	3.14	0.75	11.43	0.16	6.61
Mid-lactation	7	3.86	3.14	3.29	0.68	10.75	0.16	6.63
Late lactation	16	4.16	2.32	3.29	0.81	10.39	0.16	6.37

Table (3) shows the milk yield estimated for some farms during the period of February, March, and April, 2003. Although the rangelands with the natural vegetation were in the maximum potentiality, the milk yield ranged from 200-1000 g/day with an average of 520 g/day.

Table (3): Some estimates of milk production in goats of different types in North Sinai area.

Farm	Milk yield (g/day)
1	1000
2	800
3	400
4	400

5	200
6	400
7	600
8	400
9	600
10	400

I.C) Scientific Impact of Cooperation

As noted above, there have been considerable activities at each location in this 6-month period. Discussions among participants from each location in a project meeting in Cyprus in October were quite beneficial. In fact, based on the description of Israeli activities in the milk technology area, future work on this topic in Jordan and Egypt may be modified. Besides the exchange of information at this meeting, there is increasing communication among locations. Another pertinent area is the inclusion of Al-Quds University in East Jerusalem to perform activities in the Palestinian Authority. Dr. Uzi Merin, PI for the Israeli team, accompanied Dr. Goetsch during one of the visits to the Palestinian team, headed by Dr. Ziad Abdeen.

In terms of Jordan University of Science and Technology an active partner of USAID/MERC funded regional goat project was proud to introduce four scientists from school of Vet-Medicine and Agriculture to this regional project to investigate the situation of goat industry status in Jordan as part of the Middle East. The University has encouraged the conduction of this research, through the international cooperation. The University also has displayed the necessary tools and facilities to make the mission easy to help its team to accomplish the job. Also the Administrative and the Consultative center were very supportive and helpful on all stages of this work. The top management of our University has permitted (the principle four team members to travel during the semester postponing lectures and research to participate in regional workshops out side the country and to interact with other working teams. On the other hand we noticed that public awareness about the project was profound at JUST, the community and among students, researchers and faculty members. Goat farmers in Ajloun, Bani-Kinanh and Jarash areas were the most interested, benefited and applauding people.
This area of investigation (goat industry) have never been investigated before, the information about it never been exchanged with the neighboring Countries or discussed, the goat farming in the region has not been emphasized, the information also have never been shared with scientists in the region in such well organized plan before. The USAID/MERC funded project gave us the opportunity to be associated with international work. We feel that the Jordanian team is closer in cooperation with all teams involved in this project. The Jordanian team showed friendly relationships towards all team members used to participate in meetings and workshops, we had the opportunity to meet, dine, email, visit cards, reprints, exchanged gifts and fruitful ideas.

I.D) Project Impact

Results of this project are being used. Notable examples are the technologies transferred to goat farmers in the northern Sinai area by the Egyptian team. In October, Drs. Sahlu, Goetsch, and Merkel visited this area and many of the participating goat farms. The farmers were indeed

very pleased with these new practices, namely manufacture and use of supplemental feed blocks made from locally available byproduct feedstuffs, ammoniation via urea treatment of crop residues, and ensilage of available byproduct feedstuffs containing anti-nutritional factors. In addition, there is great interest by Sinai goat farmers in crossbreeding with Damascus goats available through this project. Farmers in Israel now are becoming increasingly aware of the high prevalence and appreciable impact of subclinical intramammary infection on goat milk yield and quality and, thus, are making appropriate production practice modifications. Results from the Jordanian team are also being used by producers. The workshops held in making goat cheese have improved production practices. Similarly, technology transfer on goat health management is enhancing disease prevention and treatment practices.

I.E) Strengthening of Middle Eastern Institutions

Evidence of strengthening of Middle Eastern institutions should be evident by information given earlier for each location in the "Research Accomplishments" section.

I.F) Future Work

OVERALL

The project is slightly behind schedule because of the length of time taken to get initial funds to the locations, occasional delays in subsequent fund transfers, and the current lack of funds available for planned activities in years 3, 4, and 5 of the project. The work plan has not been substantially changed. Because of initial milk quality findings in Israel, there has been justified attention given to subclinical intramammary infection and impacts on yield and quality of goat milk and cheese.

JORDAN

The future work will include mineral analysis of goat dairy products, the above mentioned cheddar cheese. Cheese will be produced using different rennin enzyme sources. Economic (cost) will be evaluated. The generated data and knowledge will be transferred to farmers. The previous knowledge regarding the new technology of cheddar cheese making will be transferred through workshops in other areas such as Bani Kananh, Jarash and Ajloun. Diffusion and adoption of the new technology will be preformed after these workshops will be investigated to evaluate the farmer's progress in terms of the rate of adoption, the relative advantage, compatibility, complexity, trial ability and observability by farmers.

ISRAEL

Several aspects of goat husbandry and practice in the same route are being performed at present. These include a study of 150 young does in their first kidding. Every goat will be examined a few times from parturition to the next one. Bacterial status, CAE infection, milk yield and properties will be recorded and statistically analyzed (this part of the project will

mature if the project will be financed for the future period, as the Israeli research team almost totally exhausted its resources obtained).

EGYPT

Arrangements have been made to implement artificial insemination with Damascus bucks. Semen is going to the Kantra Shark region (irrigated lands). The target is 100 does, with an expected start date of January, 2004.

According to the collected data from the area, Damascus goats have begun to dominate in the region. These Damascus goats appear to possess somewhat different characteristics than suggested by the available information on pure Damascus goats imported from Cyprus and Syria. Accordingly, a component has been added to the project activities. This is to identify the genetic structure of the genotype of goats dominant in the north part of the region. Comparisons will be made among pure local goats (samples will be collected from the south edge of the region to be free of any Damascus genetics), pure Damascus goats (samples will be collected from the flock kept in Animal Production Research Institute), and local Damascus goats raised in the region.

PALESTINIAN AUTHORITY

Initial project activities for Al-Quds University are the same as those for other locations. A questionnaire will be used to characterize goat production in the West Bank. Milk samples will be collected from different regions of the West Bank and analyzed for chemical and bacteriological properties. The possibility of a team member receiving Ph.D. training through this project at the Hebrew University of Jerusalem is being explored, with advisement by Israeli team member Dr. Nissim Silanikove.

II. Project Management and Cooperation

II.A) Managerial Issues

Participants at the different locations have expressed great concern about the need for funds for activities in years 3, 4, and 5 of the project. Actual activities began approximately 2.5 years earlier. By use of some of the funds budgeted for West Bank activities in years 1 and 2, funds for the 6 month period of year 2.0 – 2.5 were disbursed. Therefore, it is imperative that funds for years 3, 4, and 5 be received quickly in order for continuation of project activities.

In October, we received for the first time a short verbal description from USAID financial officer Mr. Dean Pike of a 'pipeline' report that needs to be prepared to receive funds for years 3, 4, and 5 of the project. Although the format of the report was not described in great detail, this report will be prepared soon and sent to USAID/MERC. It would be desirable to know who else this report should be sent to, as well as any other actions that might need to be taken.

The approval for participation of Al-Quds University took many months. This delayed

entry of Al-Quds University into the project. In fact, the approval was received after an October project meeting, for which the primary purpose was an introduction of the Al-Quds team. Their planned activities and associated collaboration with other locations was to be the focal point of the meeting. Because of this delayed approval, it was not possible for the Al-Quds participants to attend this meeting.

II.B) Special Concerns

No special concerns protocols have been changed.

II.C) Cooperation, Travel, Training, and Publications

In late July and early August, Dr. Goetsch traveled to Israel. The primary purpose of the travel was to meet with personnel of Al-Quds University to discuss possible project activities. The initial meeting occurred over a 2-day period. A few days later, a second meeting occurred, this time with participation of Dr. Uzi Merin, PI for Israeli activities. Collaboration between the Israeli and Al-Quds teams was discussed. One of the possible interactions is a student of Al-Quds receiving Ph.D. training through this project, with the degree from the Hebrew University of Jerusalem and advisement from Israeli project participant Dr. Nissim Silanikove. Dr. Goetsch also discussed Israeli project activities during the visit, including visits to participating goat farms.

In October, a 3-day project meeting was held in Larnaca, Cyprus. Attendees were Nissim Silanikove (Israel), Hassan El Shaer (Egypt), M. Tarkek Abd El Fatah (Egypt), Laith Rousan (Jordan), Tilahun Sahlu (USA), Khaled M. Al-Qudah (Jordan), Falah Shidaifat (Jordan), Essam I Shehata (Egypt), Arthur Goetsch, (USA), Uzi Merin (Israel), Gabriel Leitner, and Khalil I. Ereifej. Activity overviews were given and future collaboration discussed. As noted before, Israeli findings on effects of subclinical intramammary infection may lead to slight changes in future milk work at other locations. There was also discussion about an upcoming training function on artificial insemination in Egypt. Before the Cyprus meeting, Drs. Goetsch, Sahlu, and Merkel visited Egypt project activity sites in the northern Sinai. Dr. Merkel is the coordinator of all other international projects of the American Institute for Goat Research of Langston University and has become increasingly involved in this project.

II.D) Request for USAID Actions

As noted earlier, it is imperative that project funds for years 3, 4, and 5 be received soon for transfer to the participating locations. This concern is causing considerable problems with activity scheduling at the locations.

APPENDIX A

Table 1: Incidence of disease conditions in goats in northern Jordan.

Diseases condition	Number of examined animals	Number of affected cases	Incidence %
Caseous lymphadenitis	1432	78	5.5
Mastitis	301	17	5.6
Pneumonia	1432	31	2.2
Trichostrongylosis	1432	49	3.4
Haemonchosis	1432	74	5.2
Dictyocaulus filaria	1432	22	1.5
Liver abscess	1432	82	5.7
Rumenitis	1432	23	1.6
Orchitis	1131	2	0.2
Mange	1432	12	0.8
Oestrus ovis	1432	116	8.1
Foot rot	1432	17	1.2
Stomatitis	1432	14	1
Contagious ecthyma (orf)	1432	39	2.7
Hydatidosis	1432	57	4
Pox	1432	19	0.9
Enteritis (Coccidiosis)	1432	23	1.6
Papillomas	1432	3	0.2
Ringworm	1432	17	1.2
Arthritis	1432	9	0.6
Pinkeye	1432	5	0.3
Goiter	1432	7	0.5

Table 2: Parasites identified in the affected organs

Type of Parasite	Organ
1. GASTRO INTESTINAL TRACT PARASITES:	
a. *Trichostrongulus spp.*	Small intestine, abomasum
b. Heamonchus contractus	Abomasum
c. Moniezia expansa	Small intestine
d. *Chabertia ovine*	Large intestine
e. Cooperia curticei	Small intestine
f. Marshallagia marshalli	Abomasum, small intestine
g. *Emeria spp.*	Large intestine
2. RESPIRATORY TRACT PARASITES:	
a. *Dictyocalus filarial*	Lung, bronchi
b. *Oestrus ovis*	Nasal cavity, sinuses
3. EXTERNAL PARASITES	
a. Psoroptes Capri	Ears
b. Choriptes Capri	Skin
c. Sarcoptes seabiei	Head

Table 3: Bacteria cultured from the affected organs

Type of Bacteria	Organ
Corynebacterium pseudotuberculosis	L. N., lung
Staphylococcus aureus	Udder, lung
F. necrophorum biovar B	Liver, lung, digits
F. necrophorum biovar A	Liver, lung digits
Clostridium perfringens	Lung, liver
E. coli	Intestine, liver
Bacillus spp.	Udder, liver intestine
Pasturella spp.	Lung
Arcanobacterium pyogenes	Liver
Brucella melettenses	Intestine
Salmonella spp.	Intestine, liver
Eubacterium spp.	Intestine, liver

Extension work

Age of the response

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	21-30	6	5.7	5.7	5.7
	31-40	15	14.2	14.2	19.8
	41-50	28	26.4	26.4	46.2
	51-60	23	21.7	21.7	67.9
	>61	34	32.1	32.1	100.0
	Total	106	100.0	100.0	

Table (1): shows that 1/3 of respondents are more than 61 years old

EDU_LEV

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nothing	53	50.0	51.0	51.0
	elementary	12	11.3	11.5	62.5
	primary	22	20.8	21.2	83.7
	Secondary	10	9.4	9.6	93.3
	High school	7	6.6	6.7	100.0
	Total	104	98.1	100.0	
Missing	System	2	1.9		
Total		106	100.0		

Table (2): shows that more than a half of respondents are illiterate

Experience in goat production

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5	4	3.8	3.8	3.8
	6-10	11	10.4	10.4	14.2
	11-15	11	10.4	10.4	24.5
	15-20	12	11.3	11.3	35.8
	>21	68	64.2	64.2	100.0
	Total	106	100.0	100.0	

Table (3): indicates that 2/3 of farmers are very experienced in goat production

actial working

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	full time	68	64.2	67.3	67.3
	part time	33	31.1	32.7	100.0
	Total	101	95.3	100.0	
Missing	System	5	4.7		
Total		106	100.0		

Table (4): shows that 2/3 of respondents are full time farmers

Income from goats

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10.00	1	.9	1.1	1.1
	20.00	20	18.9	21.5	22.6
	25.00	1	.9	1.1	23.7
	30.00	5	4.7	5.4	29.0
	40.00	2	1.9	2.2	31.2
	50.00	16	15.1	17.2	48.4
	80.00	4	3.8	4.3	52.7
	100.00	44	41.5	47.3	100.0
	Total	93	87.7	100.0	
Missing	System	13	12.3		
Total		106	100.0		

Table (5): indicates that a half of respondents depend on goat production for their income

Having records

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	1	.9	1.1	1.1
	no	87	82.1	98.9	100.0
	Total	88	83.0	100.0	
Missing	System	18	17.0		
Total		106	100.0		

Table (6): shows that the majority of farmers are not keeping records about goat production

R_HEAD

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	58	54.7	100.0	100.0
Missing	System	48	45.3		
Total		106	100.0		

Table (7): shows that the majority of farmers are grazing their goats

FED_HEAD

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	75	70.8	100.0	100.0
Missing	System	31	29.2		
Total		106	100.0		

Table (8): indicates that the majority of farmers are feeding their goats

H2O_HEAD

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	76	71.7	100.0	100.0
Missing	System	30	28.3		
Total		106	100.0		

Table (9): shows that the majority of farmers are watering their goats

MIL_WIFE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	80	75.5	100.0	100.0
Missing	System	26	24.5		
Total		106	100.0		

Table (10): indicates that the majority of farmer's wives are milking the goats

MM_WIFE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	81	76.4	100.0	100.0
Missing	System	25	23.6		
Total		106	100.0		

Table (11): shows that the majority of farmer's wives are making milk

ME_HEAD

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	88	83.0	100.0	100.0
Missing	System	18	17.0		
Total		106	100.0		

Table (12): indicates that the majority of farmers are medicating their goats by themselves

CAR_HEAD

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	88	83.0	100.0	100.0
Missing	System	18	17.0		
Total		106	100.0		

Table (13): shows that the majority of farmers are caring the goats by themselves

OTH_HEAD

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	80	75.5	100.0	100.0
Missing	System	26	24.5		
Total		106	100.0		

Table (14): indicates that the majority of farmers are doing other works than above

HAD_N

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	84	79.2	98.8	98.8
	50.00	1	.9	1.2	100.0
	Total	85	80.2	100.0	
Missing	System	21	19.8		
Total		106	100.0		

Table (15): shows that the majority of farmers have goat theater

FK_HEAD

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	94	88.7	100.0	100.0
Missing	System	12	11.3		
Total		106	100.0		

Table (16): shows that 100% of farmers owned their flock

TG3_N

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	35	33.0	34.0	34.0
	2	26	24.5	25.2	59.2
	3	19	17.9	18.4	77.7
	4	10	9.4	9.7	87.4
	5	8	7.5	7.8	95.1
	6	2	1.9	1.9	97.1
	7	1	.9	1.0	98.1
	8	1	.9	1.0	99.0
	11	1	.9	1.0	100.0
	Total	103	97.2	100.0	
Missing	System	3	2.8		
Total		106	100.0		

Table (17): indicates that 1/3 of farmers have one buck older than three years

TG3_GAB

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	82	77.4	97.6	97.6
	3	1	.9	1.2	98.8
	4	1	.9	1.2	100.0
	Total	84	79.2	100.0	
Missing	System	22	20.8		
Total		106	100.0		

Table (18): shows that 97.6 % of respondents have one mountain buck

HL12_N

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	.9	1.7	1.7
	2	1	.9	1.7	3.3
	3	4	3.8	6.7	10.0
	5	3	2.8	5.0	15.0
	6	5	4.7	8.3	23.3
	7	2	1.9	3.3	26.7
	8	2	1.9	3.3	30.0
	10	4	3.8	6.7	36.7
	11	4	3.8	6.7	43.3
	12	1	.9	1.7	45.0
	13	1	.9	1.7	46.7
	14	1	.9	1.7	48.3
	15	5	4.7	8.3	56.7
	16	1	.9	1.7	58.3
	17	1	.9	1.7	60.0
	20	7	6.6	11.7	71.7
	25	2	1.9	3.3	75.0
	26	1	.9	1.7	76.7
	30	5	4.7	8.3	85.0
	35	2	1.9	3.3	88.3
	40	4	3.8	6.7	95.0
	60	2	1.9	3.3	98.3
	100	1	.9	1.7	100.0
	Total	60	56.6	100.0	
Missing	System	46	43.4		
Total		106	100.0		

Table (19): indicates that 11.7% of respondents have 20 lamb less than 12 months old

ANZ_N

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	6	1	.9	1.0	1.0
	7	1	.9	1.0	1.9
	8	1	.9	1.0	2.9
	10	4	3.8	3.9	6.8
	11	1	.9	1.0	7.8
	12	2	1.9	1.9	9.7
	13	2	1.9	1.9	11.7
	15	12	11.3	11.7	23.3
	17	1	.9	1.0	24.3
	20	3	2.8	2.9	27.2
	21	1	.9	1.0	28.2
	22	1	.9	1.0	29.1
	23	1	.9	1.0	30.1
	25	3	2.8	2.9	33.0
	26	1	.9	1.0	34.0
	27	1	.9	1.0	35.0
	28	2	1.9	1.9	36.9
	30	5	4.7	4.9	41.7
	32	1	.9	1.0	42.7
	35	5	4.7	4.9	47.6
	40	6	5.7	5.8	53.4
	42	1	.9	1.0	54.4
	45	9	8.5	8.7	63.1
	46	1	.9	1.0	64.1
	50	6	5.7	5.8	69.9
	55	1	.9	1.0	70.9
	60	3	2.8	2.9	73.8
	62	1	.9	1.0	74.8
	65	1	.9	1.0	75.7
	68	1	.9	1.0	76.7
	70	6	5.7	5.8	82.5
	80	5	4.7	4.9	87.4
	90	1	.9	1.0	88.3
	100	4	3.8	3.9	92.2
	120	1	.9	1.0	93.2
	130	1	.9	1.0	94.2
	140	1	.9	1.0	95.1
	150	2	1.9	1.9	97.1
	160	1	.9	1.0	98.1
	180	1	.9	1.0	99.0
	200	1	.9	1.0	100.0
	Total	103	97.2	100.0	
Missing	System	3	2.8		
Total		106	100.0		

Table (20): shows that 17% of farmers have 15 does more than three years old.

ANZ_GAB

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	76	71.7	98.7	98.7
	100	1	.9	1.3	100.0
	Total	77	72.6	100.0	
Missing	System	29	27.4		
Total		106	100.0		

Table (21): shows that 98.7% of respondents have one mountain doe.

RESN_1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Enterotoxemia	95	89.6	89.6	89.6
	Diarrhea	7	6.6	6.6	96.2
	Pneumonia	1	.9	.9	97.2
	Others	3	2.8	2.8	100.0
	Total	106	100.0	100.0	

Table (22): indicates that 89.6% of respondents said that Entrotoxemia was the 1st reason for goat mortality.

RESN_2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Enterotoxemia	1	.9	1.0	1.0
	Diarrhea	95	89.6	95.0	96.0
	Pneumonia	2	1.9	2.0	98.0
	Others	2	1.9	2.0	100.0
	Total	100	94.3	100.0	
Missing	System	6	5.7		
Total		106	100.0		

Table (23): shows that 95% of respondents said that Diarrhea was the 2nd reason for goat mortality.

RESN_3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Enterotoxemia	1	.9	1.1	1.1
	Diarrhea	1	.9	1.1	2.1
	Abortion in goats	90	84.9	94.7	96.8
	Pneumonia	1	.9	1.1	97.9
	Others	2	1.9	2.1	100.0
	Total	95	89.6	100.0	
Missing	System	11	10.4		
Total		106	100.0		

Table (24): shows that 94% of respondents said that Diarrhea was the 3rd reason for goat mortality.

TATH_MO

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	2	1.9	2.0	2.0
	3.00	4	3.8	4.0	6.0
	5.00	66	62.3	66.0	72.0
	6.00	24	22.6	24.0	96.0
	7.00	3	2.8	3.0	99.0
	9.00	1	.9	1.0	100.0
	Total	100	94.3	100.0	
Missing	System	6	5.7		
Total		106	100.0		

Table (25) : indicates that 66% of respondents cross breed their goats after five months

PLACE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	farm	101	95.3	100.0	100.0
Missing	System	5	4.7		
Total		106	100.0		

Table (26): shows that the majority of farmers cross breed their goats in farm

GOAT_AGE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.50	1	.9	1.1	1.1
	1.00	90	84.9	94.7	95.8
	1.50	1	.9	1.1	96.8
	2.00	3	2.8	3.2	100.0
	Total	95	89.6	100.0	
Missing	System	11	10.4		
Total		106	100.0		

Table (27) shows that 71% of respondents made the 1st matting at one year old of goat

GOAT_W

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	1	.9	1.0	1.0
	15.00	21	19.8	21.9	22.9
	25.00	68	64.2	70.8	93.8
	30.00	3	2.8	3.1	96.9
	35.00	3	2.8	3.1	100.0
	Total	96	90.6	100.0	
Missing	System	10	9.4		
Total		106	100.0		

Table (28) shows that 71% of respondents made the 1st matting at 25 kg of goat

ANZ_AGE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	90	84.9	95.7	95.7
	1.50	1	.9	1.1	96.8
	2.00	3	2.8	3.2	100.0
	Total	94	88.7	100.0	
Missing	System	12	11.3		
Total		106	100.0		

Table (29) shows that 96% of respondents made the 1st matting at one year old of goat

ANZ_W

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	1	.9	1.0	1.0
	10.00	9	8.5	9.4	10.4
	12.00	11	10.4	11.5	21.9
	15.00	1	.9	1.0	22.9
	20.00	66	62.3	68.8	91.7
	25.00	2	1.9	2.1	93.8
	30.00	3	2.8	3.1	96.9
	35.00	3	2.8	3.1	100.0
	Total	96	90.6	100.0	
Missing	System	10	9.4		
Total		106	100.0		

Table (30) shows that 69 % of respondents made the 1st matting at 20 kg of does

APPENDIX B

Double Click here to show appendix D

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Double Click here to show appendix E

Chemical Composition, [illegible]al Quality And Sensory Characteristics of Milk, Chedd[illegible] Cheese Obtained From Three Goat Phenotypes d[illegible] Lactation Periods

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ABSTRACT

Goat's milk from three phenotyp[illegible] Local (black) and Mixed (colored) was collected during three lactation periods in 2002. The milk was analyzed for moisture, protein, fat, ash and lactose content. Also milk was examined for yeast, mold and bacterial content. Cheddar and white cheese were manufactured from goat's bulk milk and examined for chemical composition and evaluated for color, taste and flavor, appearance and texture and aroma. Results showed that the chemical composition of goat's milk varied significantly during the whole year and also among the three goat phenotypes. Local (black) goats produced milk at the first lactation period with highest (44.6 %) fat content, the lowest fat content was 29.8 % for the Mixed color phenotype at the end of the year. Protein showed the same trend. Shami goat produced milk lower in lactose and ash content than the mixed color breed, whereas the Local (black) produced milk having intermediate content of lactose and ash. Cheddar and white cheese were highly acceptable. Their composition varied, cheddar cheese was higher in protein and NSF but slightly lower in fat content. White cheese retained more lactose. Goat's milk of Shami, Local (black) and Mixed color

phenotypes were found to be highly contaminated with bacteria and mold due to lack of hygiene. Milk contained low number of pathogenic bacteria. Pasteurization temperature at 73° C for 16 sec found to eliminate them.

INRTODUCTION

The goat's milk production ranks third in the world after bovine and buffalo milk. Dairy goat farming plays an important role in developing countries. Goat's milk provides one of the principle sources of animal protein in many regions, such as the Middle East, Southeast Asia and some tropical countries. Goat's milk also serves as a good substitute to cow's milk and is often recommended by the medical profession in situation where bovine milk may bring about allergic responses in individual consumers (Guo et al 1998).

Goat is a very well adapted animal to diverse environmental condition in Jordan. There are few breeds of goats raised in Jordan. The Local (black) goat which is known as Balady, Shami goat which is red in color and from Syrian origin (also known as Damascus goat) and the Mixed or colored goat which is a product of crossing between Local and Shami goats or other hybribs. Balady (Local) goat is of Jordanian origin whereas Shami has been introduced to Jordanian farmers from Syria due to its milk productivity. Goat farming is considered as an important socio-economic activity in Jordan. There are one million heads, mainly Local (black), Shami and their hybrid goat phenotypes. Goats in Jordan are raised for milk, meat and hair production. Goats are raised in small livestocks. Goat milk is very popular in the Middle East and used to be consumed as liquid milk or to produce the traditional dairy products such as yoghurt, white cheese, labaneh, Jameed, sour milk, kishek, butter, ghee and others. The goat milk industry is still considered home industry; the farmer and his family members are usually responsible for feeding, management, animal medical care, hand milking, processing and marketing the products. The demand for meat and milk in the Middle East is increasing and is projected at 3.7 and 3.1 % respectively (Hajipanayiotou Personal com.).

Because the goat farmers in Jordan lack the sound knowledge about milk technology, farming systems and management we initiated a program to help them, there for the purpose of this work is to study the microbial and chemical composition of milk and cheese obtained from three goat breeds, also to report on the variation on the chemical composition of goat milk during lactation periods.

MATERIALS AND METHODS

Goat milk samples, proximately one liter each, were collected from farms in Ajloun area once every week during the year 2002-2003 to be tested for chemical composition and microbial content. Samples were transported on ice to laboratory and kept in refrigerator at 4° C until time of analysis which usually carried out at the same day. Goat's milk samples were collected from three breeds, Shami (red in color), Local (black) and Mixed (colored). All animals were healthy, 3-5 years old and weighing 50-60 kg.

Other milk samples were collected from bulk to examine the composition of bulk milk and also to test for cheddar and white cheese manufacturing.

Chemical analysis: Goat's milk samples were subjected to chemical analysis, moisture, fat, protein (N x 6.38), ash and solid non fat (NSF) were determined according to standard procedures outlined by Richardson (1985). Lactose content was calculated by difference. Averages were recorded for each lactation period. Lactation periods were proposed as First semester or lactation period to cover goat's milk collected during Jan. Feb. March and April. The second lactation semester started May, June, July and August. The third lactation period covered Sept., Oct. Nov. and December. The same procedures were used to analyze white and cheddar cheese made from bulk goat's milk during the same lactation periods.

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Microbiological analysis:
Goat's milk samples also were subjected to microbiological analysis. To determine TPC (total plate count), yeast, mold, *Staphylococci*, *S. aureus*, *Streptococci*, *Enterobacter*, *E. coli*, coliforms, *Salmonella* and *Shigella*. Standard procedures were followed as outlined by (Vanderzant and Splittstoesser, 1992). The averages of cfu ml (colony forming unit per ml) were recorded.

Cheddar cheese manufacturing: Ten kg of goat milk were used to produce around one kg of cheddar cheese. A small water bath and small cheese vat (45x40x25 cm) were used to represent double jacketed cheese vat. Yoghurt starter, annatto and rennet enzyme were used and the cheese were prepared according to the procedure outlined by (Kosikowski 1982)

White cheese manufacturing: Ten kg of goat milk were pasteurized at 73° C for 16 seconds, and then cooled to 35° C, rennet was added. Curd was formed after 40 min; curd was cut into small cubes and separated from the whey. The curd was pressed overnight. Curd was cut into 4x5 cm and covered with dry salt for 24 hr. Cheese cuts were removed from the salt and kept in brine (12 % salt). White cheese pieces were subjected to chemical and microbiological analysis.

Sensory evaluation: Cheddar cheese was evaluated for acceptability by 25 panelists for color (20), taste and flavor (30), texture and appearance (25), and aroma (25) as shown in Table 4. Each property was given a score (shown between brackets). The panelist was asked to taste the cheese and a high score to be given if it has been liked and a lower score if it has not been liked by the panelist. The yield was computed and the titratable acidity was performed by titrating 5 g milk with 0.1 N NaOH.

Statistical analysis:
The collected data were subjected to statistical analysis using MSTATC computer program (MSTATC program, Michigan State University). The averages were compared and the LSD (least significant difference) between the means were computed according to Steel and Torrie (1982).

RESULTS AND DISCUSSION

The chemical composition of goat's milk varied significantly among Shami, Local (black) and Mixed phenotypes and lactation periods as shown in Table 1. Data in Table 1. show the chemical composition of pooled milk collected from each 6-10 goat phenotype during each lactation semester. The protein content of Shami goat varied significantly from lactation semester to lactation semester during the year. Protein content ranged from 17.3 at the end of lactation to 23.7 % at the first four lactation months. It was noticed also that the milk protein and other milk components varied from week to week or from month to month. Milk obtained from Local (black) contained higher protein than milk obtained from Shami goat and ranged from 24.6 (first semester) to 20.6 % (at the second semester). Protein content was the highest in milk collected from the Mixed (colored) breed at the first lactation semester (25.6 %). Shami goat was introduced to Jordan due to its high milk productivity. The Local black goat phenotype is known for its low milk production but it is favored for its meat.
Fat content as presented in Table 1. varied significantly and ranged from 44.6 for the first semester milk of Local (black) breed to 29.8 % for the third lactation semester of the Mixed goat breed. Lactose content also varied significantly and ranged from 44.9 for third semester of Mixed breed to 25.9 % for milk obtained from Local (black) at the first semester. Sung et.

al., 1998 reported that the major milk components varied significantly among goat breeds (Alpine, Nubian, Saanen and Toggenburg). Data on protein, fat, and lactose shown in Table 1. are in agreement with similar values reported by Sung et al 1998, Devendra 1972, Park 1991 Zeng and Escobar 1996.
Goat flocks raised by Jordanian farmers involve a mixture of Local, Shami and Mixed phenotypes. Farmers pool the milk collected from the whole flock and either sell or process it into traditional (Laban, Labaneh, white cheese, Jameed, butter milk, butter, ghee and kishek). These products are marketable. A sample from bulk milk was drawn every week during three lactation periods to be tested for chemical composition. Another sample was taken to produce cheddar cheese and to examine its chemical composition. Table 2. show the data on bulk milk chemical composition. Fat, protein, ash, lactose and nonsolid fat contents found to vary significantly during lactation periods. Protein content of bulk milk was found to be the highest during the second semester (20.5 %) and lowest during the first semester (19.1 %). Fat contents also varied significantly and found to be the highest (35.8 %) during the third lactation semester and lowest during the second semester (32.3 %). Ash content did not show significant variation during the one year lactation period. Ash content ranged from 6.3 to 5.6 % as shown in Table 2. These data are in agreement with data reported by Malau-Aduli et al 2003 and data on ewe, goat and cow's milk composition reported by Hadjipanayiotou (1994).

Lactose and SNF varied significantly and the highest values for lactose and NSF are reported for the second lactation period (41 and 67.7 %, respectively) as shown in Table 2. The major components of goat milk varied significantly during the lactation periods. It is obvious the milk content of protein, fat, lactose and ash are influenced by several factors such as breed (Zeng 1996), nutrition, animal health, management and environment. Jordanian goat farmers follow the open system because goat industry is expensive and the goat farmers cannot afford it. They relay on free grazing.
The data on chemical composition of cheddar cheese made from bulk goat's milk are presented in Table 3. Although differences in protein, fat, ash, lactose and NSF content are shown in Table 3. The differences were not statistically different during the lactation periods. Cheddar cheese made from goat milk was subjected to sensory evaluation. The differences in milk composition were reflected on the manufactured white and cheddar cheese. As shown in Table 3,7 the chemical composition of cheese varied but not significantly as affected by lactation period. Those data are in agreement with similar data reported by Fresno et al 1995 on Spanish goat's milk cheese (Armada variety).
Table 4. shows the data on sensory evaluation. As expected, cheddar cheese made from bulk goat's milk during three lactation periods did not differ significantly in color, appearance, taste and texture or aroma. The total scores ranged from 68.2 (third semester) to 76.8 (first semester). Although panelists are very familiar with the white cheese, but not the cheddar. All of them tasted to the first time the goat's cheddar cheese. Probably that might explain the non significant variation in sensory evaluation of cheese characteristics. The goat cheddar cheese was acceptable during the three milking periods and scored higher than 75 % except for the third lactation semester (68 %).

The chemical composition of white cheese made from bulk goat milk is presented in Table 5. Data show no significant variation for all major bulk milk components except for ash content which varied significantly during the whole lactation period. The explanation for that might be due to utilizing the bulk milk which is usually a mixture of milk from individual animals in the goat flock which involves more than one breed. Cheese quality is influenced by two important factors: milk composition and the effect of ripening according to Boyazoglu and Morand-Fehr (2001). The values reported in this investigation on cheese chemical composition are in agreement with similar values reported by Haenlein (1998) and Posati and Orr (1976). Haenleina (1998) reported the gross analysis of twenty type of cheeses, the Gjetost cheese of Norway which is made from goat milk has 13.4 % moisture, 42.6 % lactose, 29.5 %fat, 9.6 % protein and 4.8% ash.

Data on microbiological examination of goat milk are shown in Table 6. The total plate count (TPC), yeast and mold found to be present in goat's milk all the year around. TPC ranged

from $1.3x10^5$ to $4.1x10^5$ cfu/ml. Yeast count ranged from 3.1×10^3 (milk obtained from mixed breed) to 7.9×10^5 cfu/ml (milk obtained from Shami goat). Mold count was also high and ranged from 1.7×10^3 to $8.7x10^3$ cfu/ml. *Staphylococci* was found to range from $6.4x10^3$ (Mixed goat breed milk during the second lactation semester) to 3.5×10^3 cfu/ml. *S. aureus* was reported only once during the whole year at the first lactation period of the mixed colored goat breed. *Streptoccoci* bacteria were found in the milk of the three breeds all the year around ranging from 10^3 (first lactation period of the mixed color breed) to $5.4x10^3$ cfu/ml (milk of the Local black milk at the second lactation semester) as shown in Table 6.

Dontorou et al (2003) reported on the isolation of *E. coli* and some other bacteria from sixhundred animal foods including unpasteurized goat milk. Psoni et al (2003) also investigated the microorganisms in traditional Greec cheese prepared from raw goat milk, and reported the ocurrance of aerobic, Enterobacteriaceae, Coliforms, Staphylococci, lactic acid bacteria, Enterococci and Yeast. The number of these organism found to be reduced as storage temperature is reduced from 15 C to 4 C. The values reported in this investigation lower than the mean values reported by Psoni et al (2003).

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Table 1. **Chemical composition of goat milk collected at three lactation periods from Shami, Balady and Mixed goat phenotypes** [a]

Goat Breed	**Lactation Semester**	**Protein (%)**	**Fat (%)**	**Lactose (%)**	**Ash (%)**
	1	23.7^{a}	44.3^{a}	26.0^{c}	5.2^{c}
Shami (red)	2	18.3^{cd}	39.8^{ab}	35.6^{b}	5.0^{c}
	3	17.3^{d}	35.1^{bc}	34.9^{b}	5.5^{bc}
	1	24.6^{a}	44.6^{a}	25.9^{c}	5.0^{c}
Local (black)	2	20.6^{bc}	44.5^{a}	34.4^{b}	5.5^{bc}
	3	22.7^{ab}	35.0^{bc}	40.5^{a}	6.0^{ab}
	1	25.6^{a}	35.3^{bc}	34.1^{b}	5.2^{c}
Mixed (colored)	2	17.6^{cd}	34.4^{bc}	41.6^{a}	6.4^{a}
	3	18.9^{cd}	29.8^{c}	44.9^{a}	6.4^{a}
LSD $P<0.05$		3.1	5.8	4.7	0.7

a= Data are average of 16 samples cellected through four months as a sample per week and computed on dry weight basis

***Means in columns followed by the same letter are not significantly different according to LSD**

Table 2. **Chemical composition of goat milk collected at three lactation periods** [a]

Lactation Semester	NSF (%)	Ash (%)	Lactose (%)	Protein (%)	Fat (%)
First semester	63.1[b]	5.6[a]	38.4[b]	19.1[b]	37.0[a*]
Second semester	67.7[a]	6.3[a]	41.0[a]	20.5[a]	32.3[b]
Third semester	64.2[b]	6.2[a]	38.8[b]	19.3[ab]	35.8[a]
LSD P < 0.05	2.9	1.6	2.2	1.3	2.9

a= Data are average of 16 samples cellected through four months as a sample per week and computed on dry weight basis

***Means in columns followed by the same letter are not significantly different according to LSD**

Table 3. **Chemical composition of cheddar cheese made from bulk goat milk collected at three lactation periods**

Lactation Semester	Protein (%)	Fat (%)	Ash (%)	Lactose (%)	NSF (%)
First Semester	38.7[a]	35.0[a]	10.5[a]	15.8[a]	65.0[a]
Second Semester	37.2[a]	38.6[a]	10.2[b]	14.1[a]	65.1[a]
Third Semester	38.0[a]	36.9[a]	10.3[ab]	14.9[a]	63.2[a]
LSD P < 0.05	1.8	10.1	0.3	10.0	11.5

a= Data are average of 16 samples cellected through four months as a sample per week and computed on dry weight basis

***Means in columns followed by the same letter are not significantly different according to LSD**

Table 4. **Sensory characteristic of cheddar cheese made from bulk goat milk collected at three lactation periods (data average of 16 samples and computed on dry weight basis)**

Lactation Semester	Color (20)	Appearance (15)	Taste (30)	Texture (15)	Aroma (20)	Total (100)
First semester	17.8[a]	10.5[a]	23.4[a]	10.8[a]	14.3[a]	76.8[a]
Second Semester	18.6[a]	12.0[a]	22.2[a]	8.3[a]	15.0[a]	76.0[a]
Third Semester	14.3[a]	8.3[a]	21.3[a]	9.3[a]	14.8[a]	68.2[a]
LSD $P < 0.05$	5.3	5.8	9.3	4.0	5.3	23.4

a= Data are average of 16 samples cellected through four months as a sample per week and computed on dry weight basis

***Values in columns followed by the same letter are not significantly different according to LSD**

Table 5. **Chemical composition of white cheese made from bulk goat milk collected at three lactation periods**

Lactation Semester	Protein (%)	Fat (%)	Ash (%)	Lactose (%)	NSF (%)
First Semester	25.6 [a]	39.6[a]	9.4 [a]	25.4 [a]	60.1 [a]
Second Semester	26.1 [a]	43.3[a]	9.6 [b]	20.7 [a]	56.2 [a]
Third Semester	26.0 [a]	41.6 [a]	9.6 [ab]	23.0 [a]	58.5 [a]
LSD $P < 0.05$	0.6	4.1	0.3	5.8	4.1

a = Data are average of 16 samples cellected through four months as a sample per

week and computed on dry weight basis

*** Means in columns followed by the same letter are not significantly different according to LSD**

Table 6. **Microbiological analysis of milk obtained from three goat breeds during three lactation periods**

Goat Breed	Lactation semester	TPC	Yeasts	Molds	Staphylococcus	S. aeureus	Streptococcus	Enterobacteriacea	E. coli	Coliforms	Salmonella	Shigella
Shami	1	$1.7x10^5$	$3.3x10^4$	nd	$2.0x10^3$	-	$1.7x10^3$	$6.9x10^4$	-	nd*	-	-
	2	$4.1x10^5$	$7.9x10^5$	$1.4x10^3$	$1.9x10^3$	-	$4.8x10^3$	$2.8x10^6$	-	$3.6x10^2$	-	-
	3	$2.7x10^5$	$6.4x10^5$	$3.7x10^3$	$3.5x10^3$	-	$2.8x10^3$	$6.5x10^2$	-	$5.2x10^1$	-	
Local	1	$1.9x10^5$	$4.4x10^4$	9.1	$2.3x10^3$	-	$4.4x10^1$	$7.3x10^4$	+	nd	+	
	2	$2.2x10^5$	$5.2x10^5$	$4.2x10^3$	$2.2x10^3$	-	$5.4x10^3$	$3.6x10^4$	+	$1.2x10^2$		
	3	$1.3x10^5$	$1.2x10^5$	$8.7x10^3$	$2.8x10^3$	-	$2.8x10^3$	$6.5x10^3$	+	$9.3x10^1$		
Mixed	1	$3.8x10^5$	$3.1x10^3$	9.1	$1.6x10^3$	+	$1.0x10^3$	$2.4x10^4$	-	nd		
	2	$4.7x10^4$	$1.4x10^5$	nd	$6.4x10^2$	-	$1.2x10^3$	Nd	-	nd		
	3	$2.0x10^5$	$1.6x10^5$	$7.5x10^3$	$2.8x10^3$	-	$5.2x10^3$	$7.2x10^3$	+	$9.4x10^1$		

a= Data are average of 16 samples cellected through four months as a sample per week

nd= not detected

Table 7. **Microbiological examination of cheddar cheese**

Lactation semester	TPC	Yeasts	Molds	Streptococci	Other Bacteria
First emester	**$4x10^4$**	**$5x10^4$**	-*	**$2x10^4$**	-
Second emester	**$3x10^4$**	**$7x10^4$**	-	**$1x10^4$**	-
Third Semester	**$6x10^4$**	**$5x10^4$**	-	**$1x10^4$**	-

a= Data are average of 16 samples cellected through four months as a sample per week

* - = not detected

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Effect of subclinical intramammary infection on somatic cell counts, *NAGase* activity and gross composition of goat's milk

(Accepted for publication – Journal of Dairy Research)

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SUMMARY

The present study aimed to identify the pathogens causing subclinical udder infections in representative Israeli dairy goatherds and to determine their effect on milk quality. Five hundred goats in 10 flocks of various breeds and crossbreeds were surveyed. Of the 500 goats, 13.4% were in their first lactation, 36.4% were in their second lactation and 50.2% were in their third or higher lactation. The percentage of udders halves with subclinical intramammary infection in the flocks ranged from 35 to 71%. The effect of the bacteriological infection on somatic cells count (SCC) was significant ($P < 0.001$). Various species of coagulase-negative staphylococci (CNS), mainly *Staphylococcus caprae* and *Staphylococcus epidermidis*, formed the main pathogen group in infected udder halves. Lactation number did not significantly influence either the infection rate of udder halves or the SCC, although the percentage of udder halves with no bacteriological findings was higher at the first lactation than at the third lactation. Milk composition – fat, protein and lactose – varied among flocks, with lower mean total protein in uninfected halves than in infected ones and higher lactose in uninfected than infected halves.

KEYWORDS: subclinical mastitis, milk composition, goat

Intramammary infection (IMI) raises somatic cell count (SCC) and reduces milk yield and milk quality in dairy cows (Harmon, 1994) and sheep (Watson & Buswell, 1984), but in goats this interrelationship is less clear (Haenlein & Hinckly, 1995, Sanchez *et al.* 2002). In goats, involution tends to be spontaneous and is associated with the increase of SCC independently of IMI, which confounds the interrelationship between IMI and milk yield (Foschino *et al.* 2002; Wilson *et al.* 1995, Zeng & Escobar, 1996).

In goats, the possible limitations of bacteriological analyses as gold standard in mastitis diagnosis can not be supplied by the indirect test proposed, such as SCC, California mastitis test (CMT) or *N-acetyl-β-D-glucosaminidase* (*NAGase*) activity. The validity parameters of these tests in goat milk are not definitively reported and further studies are necessary for different goat breeds and systems of production. In cows, SCC is an indication of normal or abnormal milk while for goat milk, it is inappropriate because of the presence of many cytoplasmic particles resulting from apocrine milk secretion (Maisi, 1990; Atherton, 1992). However, using Fossomatic calibrated with goat milk, CMT or even Coulter Counter after applying an appropriate correction factor could be used as indirect tests (Heanlein, 2002). In earlier studies in dairy cows (Chaffer *et al.* 1999; Leitner *et al.* 2001) and dairy sheep (Leitner *et al.* 2003) the changes accruing throughout lactation in the bacteriological status of a mammary gland (quarter or half) were minimal with a high correlation between the pathogens identified, SCC and *NAGase* activity. These results indicate that testing cows and sheep once in mid lactation gives a good indication of the udder bacteriological status. In goats, indirect tests are questionable if carried out shortly after kidding and towards the end of the lactation.

The present study aimed to identify the pathogens causing subclinical udder infections in representative Israeli dairy goatherds and to determine their influence on milk quality. This was done by single sampling of milk of individual udder half between 25 and 130 d post partum.

Materials and methods

Animals

Ten Israeli dairy goatherds representing various breeds (Saanen, Shami) and crossbreeds (Shami x Anglo Nubian, Saanen x Anglo Nubian), from different locations, size of herd (150 to 800 goats) and lactation number (1 to 9) were surveyed. From each herd, 50 goats were randomly chosen from the pool of goats that were at least 25 d and not more than 130 d after kidding. Annual lactation milk yield of these herds ranged from 350 to 1200 l/goat and the daily yield ranged between 0.5 to 6 l/d. Under Israeli goatherd management, the kids are removed immediately after birth and the goats are milked with milking machine twice a day with teat post-dipping only. At drying-off, no treatment is applied. Food is usually offered in mangers in free stall barns.

Milk sampling

In each goat, udder halves were sampled and tested for udder bacterial condition, SCC, *NAGase* activity and for the concentration of fat, protein and lactose in milk. Udder halves were sampled during the morning or evening milking. Teats were cleaned and disinfected before sampling with non-woven toweletts moistened with chlorhexidine, cetrimide and ethanol (MediWipes, Al-Baad, Massuot Itzhak, Israel).

The first few squirts of milk were discarded and approximately 5 ml of milk was then sampled in a sterile tube for bacteriological testing and NAGase activity. Samples were taken aseptically according to International Dairy Federation procedures (1985) and kept at 4-8 °C until tested at the laboratory (1-5 h). SCC and milk composition were determined according to the revised protocol of the A2B sub-group of Mastitis Experts of the International Dairy Federation, IDF (1991). Foremilk (50 ml) was taken from each half to determine SCC with a Fossomatic 360 and milk composition with a Milkoscan 6000 (Foss Electric, Hillerød, Denmark), both calibrated with goat milk, at the Milk Control Laboratory, Israel Cattle Breeders Association, Caesarea, Israel.

Bacteriological procedure

Bacteriological examination was performed according to accepted standards (Hogan *et al.* 1999): 0.01 ml of each milk sample was spread onto blood-agar plates (Bacto-Agar, Difco Laboratory) containing 5% of washed sheep red blood cells and on MacConkey plates. All plates were incubated at 37 °C and examined for growth at 18 and 42 h. Colonies suspected to be staphylococci were tested for coagulase (tube test, Anilab, Rehovot, Israel). Strain identification was carried out with the API STAPH-IDENT, 32 Staph kit (bioMerieux S.A., 69280 Marcy-l'Etoile, France). When the percentage of micrococci-like bacteria that matched the test strain exceeded 90%, the strain was regarded as specific. If the percentage fell below 90%, the strain was registered as unidentified coagulase negative staphylococci (CNS). Gram-negative colonies were identified with the API 20 E or API NE kit (bioMerieux S.A., 69280 Marcy-l'Etoile, France).

NAGase test

The concentration of *NAGase* was determined fluorimetrically according to the ADL MILK *NAGase* test kit (Applied Diagnostics Corporation, Helsinki, Finland) with a computerized microplate setting. A value of 100 corresponds to the release of substrate-derived product at 5 µmol l^{-1} min^{-1} at 25 °C

Statistical analysis

Results were analysed with the SAS General Linear Model procedure (SAS/STAT® User's Guide, 1990). No differences were found in the arithmetic means of IMI parameter and milk composition between all the herds and the 6 goatherds that had a complete dataset. Therefore, statistical analysis was done only on 6 goatherds that had recorded days in milk (DIM). Dependent variables were SCC and Log SCC, *NAGase*, fat, protein and lactose. The independent variables – bacteriological status, flock, lactation number and DIM – were examined according to the model

$$Y_{ijk} = \mu + B_i + H_j + L_k + DIM_{ijk} + e_{ijk}$$

where: Y = dependent variable; µ = overall mean, B = bacteriological status I = 1,2, H = flock, J = 1,..6; L = lactation number, k = 1,2,3+, DIM - days in milk is a continuous variable; e – error.

No significant difference was found between morning and evening milk sampling and most (8 of 10 herds) were sampled in the morning, thus this variable was excluded from the model. No significant difference was found between analyses based on SCC and those based on Log SCC.

Results

Table 1 depicts the distribution of the five hundred surveyed goats according to flock, lactation number and average number of days in milk. Of the 500 goats, 13.4% (67 500) were in their first lactation, 36.4% (182 500) were in their second lactation and 50.2% were in their third or higher lactation (251 500). The percentage of bacteriologically infected udder halves in the flocks ranged from 35 to 71%. Lactation number (1, 2, and 3 or more) affected the infection rate of udder halves: the percentage of uninfected udder halves was higher but not significant for first and second lactations than for third lactation (54, 56 and 31%, respectively). The correlation between SCC and *NAGase* activity was low ($R < 0.7$). No interaction was found between bacteriological status and flock in its effect on SCC or *NAGase* activity. The statistical analysis of the effect of bacteriological status (infected or uninfected half) was found significant for both *NAGase* and SCC ($P < 0.001$). Flock effect was found significant for *NAGase*, SCC and log SCC ($P < 0.01$)(Table 2). The effects of lactation number and days in milk on SCC were not significant.

No bacterial growth was detected in the milk of 48% (488 out of 1000 halves) and those were accordingly classified as uninfected. *Staphylococcus aureus* was detected in eight flocks, in only one to six goats per flock, and they caused strong responses in SCC, which increased > 3 x 10^6 cells/ml (Table 3). Various species of CNS formed the main pathogenic group in infected udders and for the majority of the CNS species, infection of one half did not affect the other. *Staphylococcus caprae* and *Staphylococcus epidermidis* formed the majority of the CNS and they were found in all the flocks tested (Table 3). Other major CNS were *Staphylococcus chromogenes* and *Staphylococcus simulans*. The presence of CNS elicited strong inflammatory responses increasing SCC to 10^6 cells/ml with no significant difference among the various strains

(Table 3). Statistical analysis of each of the 5 CNS species in the model was found not significant for all the depended variables

Milk fat, protein and lactose concentrations varied among flocks in the ranges 19.9 to 55.6 g/l for fat, 34.0 to 51.1 g/l for total protein and 47.4 to 51.1 g/l for lactose. Statistical analysis for the 6 goatherds that were included in the model revealed that the mean total protein and fat were lower in uninfected halves than that in infected ones (39.1 vs. 39.9 g/l for protein and 37.5 vs. 42.0 g/l for fat), whereas lactose was higher in uninfected than in infected halves (49.6 vs. 47.2 g/l). Effects of bacteriological status (infected or uninfected) for the 6 goatherds were not significant for fat and significant ($P < 0.01$ and < 0.001) for protein and lactose, respectively (Table 4). The flock effect on all of the parameters was significant ($P < 0.001$) whereas that of lactation number was significant for protein and lactose and not for fat and that of DIM for fat and protein and not for lactose (Table 4).

Discussion

CNS, mainly *Staph caprae*, *Staph epidermidis*, *Staph chromogenes* and *Staph simulans*, were the most abundant bacterial isolates, and were found in almost all flocks tested. *Escherichia coli*, *Staph aureus*, *Streptococci* and *Pseudomonas* spp. are commonly isolated from cases of clinical mastitis (reviewed by Menzies & Ramanoon, 2001) therefore, the numbers of goats that were found to be infected with these bacteria in the present study did not reflect their frequencies in the flocks. Moreover, in the last 5 years, sheep and goat flocks in Israel have suffered from outbreaks of mastitis caused by *Pseudomonas aeruginosa* (Rapoport *et al.* 1998) and those which were acute with clinical symptoms were removed from the flocks

Eeffects of all CNS isolates in this study on the mammary glands, as indicated by SCC, were similar, they increased SCC above 1,000 x 10^3 cells/ml. This trend was discussed in the review by Haenlein (2002), reporting over 10^3 cells/ml in response to CNS IMI in different countries. Other factors such as lactation, DIM and caprine arthritis-encephalitis virus infection were reported to be associated with increased SCC in goats (Haenlein and Hinckley, 1995; Ryan *et al.* 1993, Wilson *et al.* 1995). However, avoiding sampling goats immediately after parturition and not more than 130 d after kidding reduced the contribution of lactation number and DIM in the present work and strongly suggested that increased SCC is associated with IMI during this period. Therefore, it is strongly suggested that within the limit of the above period SCC or *NAGase* activity should be complemented with bacterial testing to assess IMI. Moreover, in Israel most of the milk is yielded during this period (25-130 days), therefore, the increase in SCC regardless of IMI towards the end of lactation have lower effect on the bulk milk SCC. A similar association between infection with CNS and high level of SCC was also found in sheep (Fthenakis, 1994, Gonzalez-Rodriguez *et al.* 1995; Las Heras *et al.* 1999; Leitner *et al.* 2001), indicating that the immune response in sheep and goats is more acute than in cows, although normal SCC in goat and sheep are higher than that reported normally in cows (Paape & Capuco, 1997).

Intramammary infection, even if restricted to subclinical effects, has been reported to decrease milk yield in sheep (McCarthy *et al.* 1988; Fthenakis & Jones, 1991, Leitner *et al.*, 2003). One of the basic features of mammary secretion is that the total osmotic pressure of the secretion remains approximately constant and equal to that of the blood (Holt, 1993). As lactose is the main osmotic component in milk, the secretion volume follows the changes in the secretion of lactose very closely (Shamay *et al.*, 2000). Thus, based on the decrease in lactose concentration in the infected

glands, it is assumed that subclinical mastitis is associated with reduced milk yield also in goats. The decrease in lactose concentration in the infected halves is consistent with similar findings in sheep (Burriel, 1997; Leitner *et al.*, 2003). However, it remains unclear whether the decrease in lactose concentration is related to microbial activity or to the effect of plasmin-induced casein-derived products on mammary epithelial cells (Shamay *et al.*, 2002, 2003).

The milk of 6 of the 10 farms participated in the present study is processed by the owners into fermented milk products and cheese, so any changes in the dry matter, mainly casein concentration, have an economical influence on the producer. In the present study, levels of fat and total protein were significantly higher in the infected halves than in the uninfected ones, consistent with recent findings in sheep (Leitner *et al.*, 2003). In dairy cows, Auldist *et al.* (1996) found that milk with high SCC exhibited an extended coagulation time and formed a weak coagulum, so that the cheese had increased moisture content and the dry matter yield was reduced. Schaar & Funke (1986) found that milk from a mastitic cow's udder showed increased proteolytic activity and was associated with reduced concentration of caseins and increased whey protein concentration. Therefore, measurements of casein yield, casein proportions and curd yield and parameters reflecting cheese quality are essential measures to assess the effect of subclinical mastitis on cheese yield and its quality in goats.

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Table 1. Distribution of the 500 various breeds and crossbreeds of dairy goats, according to flock, lactation number and average (± SD) days in milk (DIM).

Flock	Lactation			DIM[1]
	1	2	> 3	
1	2	36	12	95±50
2	2	8	40	31±5
3	2	24	24	-
4	6	18	26	-
5	6	13	31	-
6	2	26	22	104±114
7	12	13	25	77±17
8	3	9	38	-
9	15	20	15	50±2
10	17	15	18	105±92
Total	67	182	251	

DIM – days in milk

[1] - Four goatherds did not record DIM

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Table 2. Mean and SE of *NAGase* activity and somatic cells count by Fossomatic 360 according to udder bacteriological status and flock, lactation number and days in milk effects of 6 goatherds

Status	*NAGase*	SCC x 10^3	log SCC
Uninfected (327)	15.6±0.8	338±29.0	5.12±0.07
Infected (273)	59.2±5.3	1922±109.8	6.83±0.08
Effects:			
Bacteriological status	< 0.001	< 0.001	< 0.001
Flock	< 0.01	< 0.01	< 0.01
Lactation	NS	NS	NS
Days in milk	NS	NS	NS

Table 3. Distribution of 500 dairy goat udders (1000 halves) from 10 different flocks, according to udder bacteriology infection and SCC measured with Fossomatic 360.

Bacteria	Udder half	Flock	SCC x 10^3	Log SCC
Staph aureus	38	8	3593±259	6.49±0.04
CNS				
Staph caprae	167	10	1426±205	5.93±0.04
Staph chromogenes	41	8	1744±236	6.06±0.07
Staph epidermidis	95	10	1529±208	6.02±0.04
Staph simulans	66	10	1996±182	6.16±0.05
Staph xylosos	13	4	791±192	5.8±0.08
Non identified CNS	53	8	1189±205	5.63±0.1
Total CNS	435	10	1676±74	5.99±0.02
Other & Not identified	39	9		
Total uninfected[1]	488 (48%)		288±21.1	5.19±0.02
Total infection	512 (52%)		1626±70.8	6.00±0.02

[1] Uninfected halves, no bacterial growth on blood-agar and MacConkey plates

Table 4. Mean and SE of fat, protein, and lactose, according to udder half bacteriological status and according to udder bacteriological status, flock, lactation number, time of milking and days in milk effects of 6 goatherds.

Status	Fat	Protein	Lactose
		g l	
Uninfected (327)	37.5±0.09	39.1±0.03	49.6±0.02
Infected (273)	42.0±0.09	39.9±0.03	47.2±0.03
Effects:			
Bacteriological status	NS	< 0.001	< 0.001
Flock	< 0.001	< 0.001	< 0.001
Lactation	NS	< 0.001	< 0.001
Days in milk	< 0.001	< 0.001	NS