FACTORS AFFECTING COMPOSITION AND QUALITY OF GOAT MILK

Young W. Park

Georgia Small Ruminant Research & Extension Center
Fort Valley State University
Fort Valley, GA 31030-4313
And
Department of Food Science and Technology
The University of Georgia
Athens, GA 30602

INTRODUCTION

- **The goat has been the most maligned domesticated animal in many parts of the world, partly due to offensive odor of the buck, whose odor floats around and can affect the flavor of doe's milk.**
- **However, recent study showed that goat milk properly milked and cooled is odor free and hard to distinguish from cow milk in odor and taste (Mowlem, 1988; Park and Haenlein, 2006).**
- **Thus, the production of quality goat milk is possible, which has made great progress lately in dismantling the old prejudice on goat milk by consumers (Haenlein, 2006).**
- **There has been a phenomenal increase in dairy goat numbers around the world in recent years (FAO, 2002; Park and Haenlein, 2006).**

Requirements for Quality Dairy Goat Products

- The products should have good flavor and no objectionable flavor, free from spoilage organisms, and contain legal limits of all nutrients.
- The products must be safe to consume and free of pathogenic bacteria, antibiotic, insecticide and herbicide compounds.
- The products should have good appearance, taste, freshness, and rheology (texture) , etc.

St. Helens Farm-Milking Parlor, UK

Recommended Procedures For Production of Good Quality Milk

1. Healthy and clean animals and udders.
2. Proper feeding, balanced ration, meeting nutrient requirements, especially in minerals.
3. No feeding of milking animals prior to milking for at least 2 hours, especially feeds and forages with odors.
4. Clean air in separate milking room, and clean hands and cloths when handmilking.
5. Dry, clean wiped udders and teats; for stripped teats.
6. Proper, sufficient and steady vacuum during machine milking.

Recommended Procedures for Production of Good Quality Milk (Cont'd)

7. Low "true" somatic cell counts (neutrophil leucocytes) in milk.

8. Low preincubation and standard plate counts, as well as low cold-resistant (psychotropic) bacteria counts in milk.

9. Rapid water cooling or refrigeration after milking.

10. Constant low milk storage and transportation temperatures.

11. Clean milking equipment, cans, strainers, pipelines, and tank.

12. CIP washing needed for equipments and utensils, before and after pasteurization and processing of milk (Exposure of equipments to hot water at 120^{o}F or higher after an initial lukewarm rinse for each AM and PM milking, and final sanitizing solution before each milking).

Secretory processes for Milk Quality

Three types of milk secretion:

1. Merocrine secretion

   The movement of secretion products through epithelial cells without injury to the cell membrane (cow milk secretion).

2. Apocrine secretion

   Migration of secretory products to the apex of epithelial cell, where rupture of the cell membrane takes place to release the secretory products. (Parts of the cytoplasm secreted in the milk) (Goat milk secretion).

3. Holocrine secretion

   The entire epithelial cell disintegrates to become part of the secretion, where cytoplasmic fragments and nuclei exist in the milk (Goat milk secretion).

Milking Dairy Sheep Barn, Zaragoza, Spain

Idiazabal Sheep Cheese

The 5-point Mastitis Control Program for Reduction of Somatic Cell Counts Promoted by National Mastitis Council, USA.

1. Use only functionally adequate milking machines, or hand milking in the correct manner.
2. Dip teats after each milking with an effective, approved product.
3. Administer promptly a full series of recommended treatments to all clinical cases of mastitis.
4. Treat udder halves at drying-off of goats with an approved antibiotic preparation for drying-off.
5. Cull animals with chronic infections when they do not respond to treatments.

Machine milking prevails in larger herds. Photo courtesy of G. F. W. Haenlein, University of Delaware.


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Statistical summary of total bacterial cell counts (TCC), coliform counts (CFC), staphylococcus count (STC), somatic cell counts (SCC), percent fat, and percent protein for the pooled data of Alpine and Nubian goats.[a]

	No. of Observation	Mean	Range[b]	SE
TCC (x 10^4/ml)	104	1.544	0.01-34.7	0.533
CFC (x 10^3/ml)	85	0.966	0.00-8.90	0.169
STC (x 10^3/ml)	90	3.323	0.00-40.0	0.633
SCC (x 10^5/ml)	104	9.08	0.00-62.0	1.060
Fat, %	105	4.47	1.62-7.92	0.134
Protein, %	105	3.42	2.36-5.00	0.051

[a]Adapted from Park and Humphrey (1986).

[b]Zero means less than unit counts

Correlation Coefficients among total bacterial cell counts (TCC), coliform counts (CFC), staphylococcus count (STC), somatic cell counts (SCC), percent fat, and percent protein for the combined data of Alpine and Nubian goats.[1]

	TCC	CFC	STC	% Fat	% Protein
SCC	-0.137	-0.304	0.167	0.415**	0.412**
TCC		0.321**	0.171	0.071	0.011
CFC			-0.136	-0.025	0.045
STC				0.144	0.333**
% Fat					0.655**

[1]Number of observation is based on the previous Table values.

**P<0.01

Adapted from Park and Humphrey (1986).

Sensory Evaluation Method

1. **A sensory panel (n=7, 6 females, 1 male) evaluated the cheeses using a previously published lexicon for cheese flavor adapted for goat cheeses.**

2. **The definition and the references for the terms used were given in Table 1. (Drake et al., 2001).**

3. **Flavor and taste intensities were scaled using a 10-point intensity scale with the Spectrum™ method (Meilgaard et al., 1999; Drake et al., 2001).**

Sensory Evaluation Method

4. **Panelists had each received 150 h training on aroma and flavor evaluation of cheeses, including soft goat cheeses.**

5. **Cheeses were presented in 2 x 2 cm cubes with three digit codes.**

6. **During evaluation, panelist had free access to water and unsalted crackers.**

Goat cheese lexicon and references

Term	Definition	References
cooked/milky	aromatics associated with cooked milk	skim milk heated to 85 °C, 30 min
whey	aromatics associated with Cheddar cheese whey	fresh Cheddar whey
diacetyl	aromatics associated with diacetyl	diacetyl
milkfat/lactone	aromatics associates with milkfat	fresh coconut meat, heavy cream, δ-dodecalactone
waxy/animal	waxy/crayon-like aromatic primarily associated with cheeses made from goat or sheep's milk	4-methyl octanoic acid and 4-ethyl octanoic acid 100 ppb of each in MeOH in a sniffing jar
brothy	aromatics associated with boiled meat or vegetable stock	Knorr beef broth cubes, Knorr vegetables broth cubes, canned potatoes
sweet	fundamental taste sensation elicited by sugars	sucrose (5% in water)
salty	fundamental taste sensation by salts	sodium chloride (0.5% in water)
sour	fundamental taste sensation by acids	citric acid (0.08% in water)

Table 3. Comparison of effects of storage on sensory scores of unfrozen with frozen-thawed plain soft goat cheese aged at 4°C for 0, 2 and 4 weeks

	0 week		2 weeks		4 weeks	
	Fresh Unfrozen	Frozen-thaw	Fresh Unfrozen	Frozen-thaw	Fresh Unfrozen	Frozen-thaw
Cooked/milky	2.3a	2.3a	2.0b	2.0a	1.7c	1.7c
Whey	2.0a	2.0a	1.6b	1.7a	1.0c	1.0b
Milkfat	3.0a	2.9a	2.5b	2.5a	1.8c	1.9b
Waxy/animal	3.0a	3.1a	3.0a	2.9a	2.8a	2.8a
Brothy	0.5b	0.7b	1.0a	0.9a	1.0a	1.0a
Yeasty	0.0c	0.0c	1.0b	1.0b	3.8a	2.0a
Diacetyl	1.5a	1.1a	1.0b	0.5b	0.2c	0.2c
Sweet	2.0a	2.0a	1.9a	1.5b	1.0b	1.0b
Sour	3.7a	3.7a	3.7a	3.8a	3.0b	3.0b
Salty	3.3a	3.3a	3.5a	3.5a	2.5b	2.8b
Oxidized	0.3c	0.3c	1.1b	1.7b	2.8a	2.8a
Freshness	7.5a	7.0a	5.0b	5.1b	3.0c	3.2c


Raff

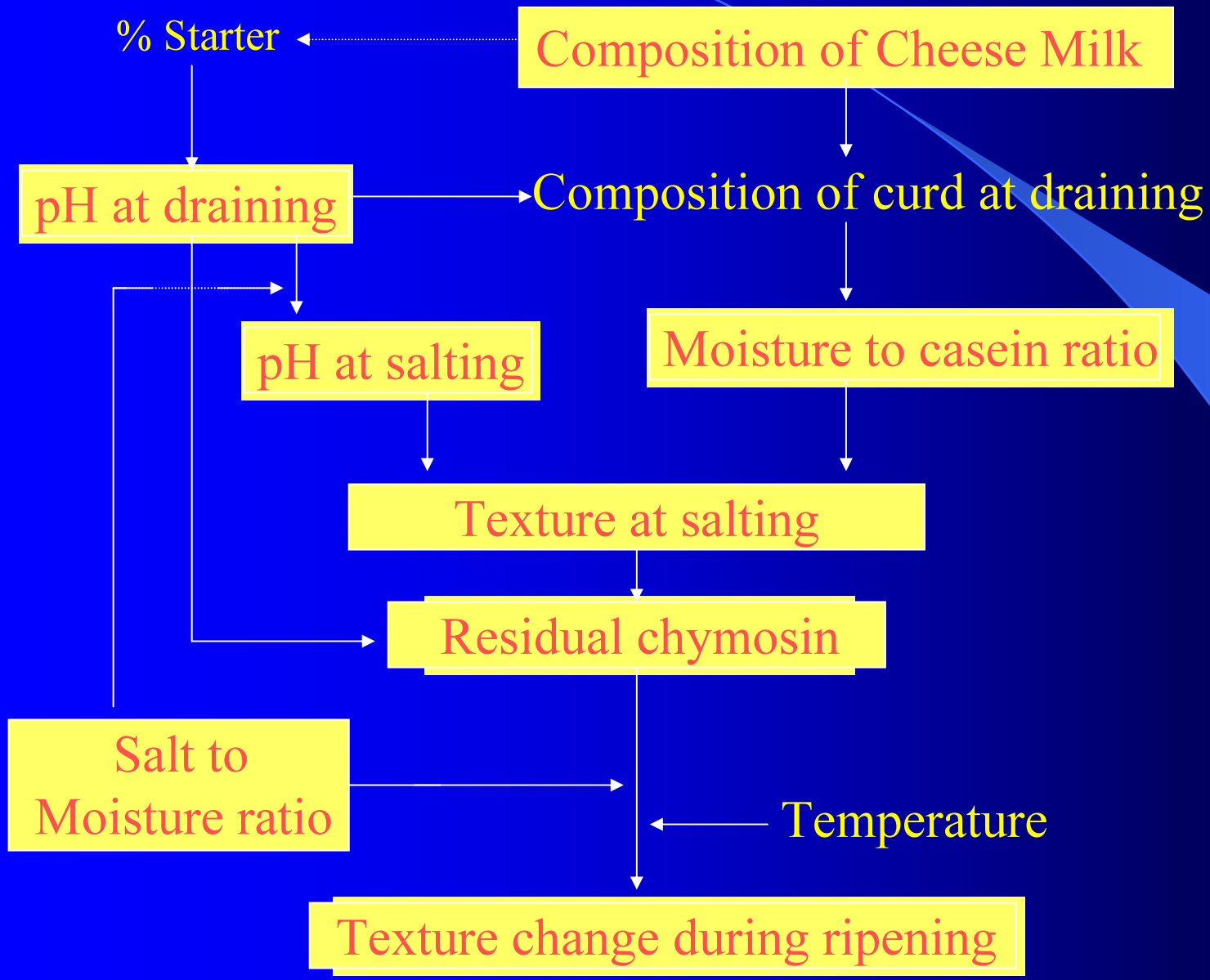
Total counts, yeast and mold counts (log cfu/g) and pH in commercial soft goat milk cheeses stored fresh unfrozen and frozen-thaw, then aged at 4°C for 4 weeks.

Storage Treatment	Aging 4°C (day)	N	TPC Mean	TPC SD	Yeast Mean	Yeast SD	Mold Mean	Mold SD	pH Mean	pH SD
Fresh Unfrozen	0	9	8.93	0.68	4.80	0.40	3.20	0.17	5.79	0.177
	14	9	6.00	0.61	5.83	0.40	3.37	0.63	6.07	0.177
	28	9	5.87	0.74	6.17	0.68	3.17	0.29	6.03	0.177
Frozen-Thaw	0	9	8.30	0.46	4.03	0.91	3.00	0.00	5.95	0.177
	14	9	5.80	0.96	4.36	1.72	3.17	0.29	6.00	0.177
	28	9	6.17	0.75	5.86	1.36	3.10	0.17	5.95	0.177

Chemical and Physical Hazards for Dairy Products (IDFA, 1998)

Chemical Hazards		Physical Hazards
Natural toxins	Mycotoxins; - a. Acute: Ochratoxin, Trichothecene, Zearalenone, Aflatoxin b. Chronic: Aflatoxin, Sterigmatocystin, Patulin Other natural: Thyro-toxicosis	Metal Glass Insect/pest parts Dirt Wood fragments Personal effects Plastic Others
Metals	Copper, Cadmium, Mercury	
Drug Residues	Beta-lactams, Sulfonamides, Tetracyclines, Others	
Sanitizer residues	Chlorinated, Fatty acid, Iodophors, others	
Pesticide residues		
Allergens	Peanuts, Tree nuts	
Food additives		
Inadvertent chemicals	Lubricants, Boiler additives	

Factors Affecting Changes in the Texture of Cheddar Cheese During Ripening



Prerequisite areas of developing a HACCP plans

1. Premises
   - a. Outside Property
   - b. Building
   - c. Sanitary Facilities
   - d. Water Quality Program
2. Receiving/Storage/Shipping
   - a. Receipt of raw materials, ingredients, and packaging materials
   - b. Specifications
   - c. Storage
   - d. Distribution
3. Equipment performance and maintenance
   - a. General Equipment Design
   - b. Equipment Installation
   - c. Equipment Maintenance
4. Personnel Training Program
   - a. Manufacturing Control
   - b. Hygienic Practices
   - c. Controlled Access
   - d. Personnel Safety
5. Cleaning and Sanitation
   - a. Cleaning and sanitation program
   - b. Pest Control Program
6. Recall Programs
   - a. Traceability
   - b. Recall System
   - c. Recall Initation
7. Supplier Control Programs
   - a. Performance Criteria
   - b. Alternative Sources

LIPOLYSIS IN MILK

1. **Induced Lipolysis:**
   a. Processing factors; Agitation, foaming, homogenization, and freezing and thawing (Activation by temp changes).
   b. Temperature factors; During transportation, storage and processing.
   c. Farm factors; Milking machines, pipelines, pumping, bulk tank.

2. **Spontaneous Lipolysis:**
   a. Milk processing factors; cooling, mixing and separation.
   b. Animal factors; Lactation stage, feed, season, breed, mastitis, milk and fat yield, physiological factor.

3. **Microbial Lipolysis:**
   a. Microbial lipases
   b. Psychrotrophic bacterial lipases

FACTORS AFFECTING LIPOLYSIS IN CHEESE

1. **Free fatty acids**
2. **Lipolytic enzymes**
3. **Lipolytic microorganisms**
4. **Temperature**
5. **Storage time**
6. **Oxygen concentration**
7. **Moisture content**
8. **Presence of Antioxidant and pro-oxidant**

Factors affecting composition and yield of milk

1. Species
2. Breed
3. Individual animal
4. Stage of lactation
5. Colostrum
6. Age and parity
7. Body weight at kidding
8. Feed (diet)
9. Season
10. Environment (temperature and humidity)
11. Disease
12. Length of dry period and gestation

Species

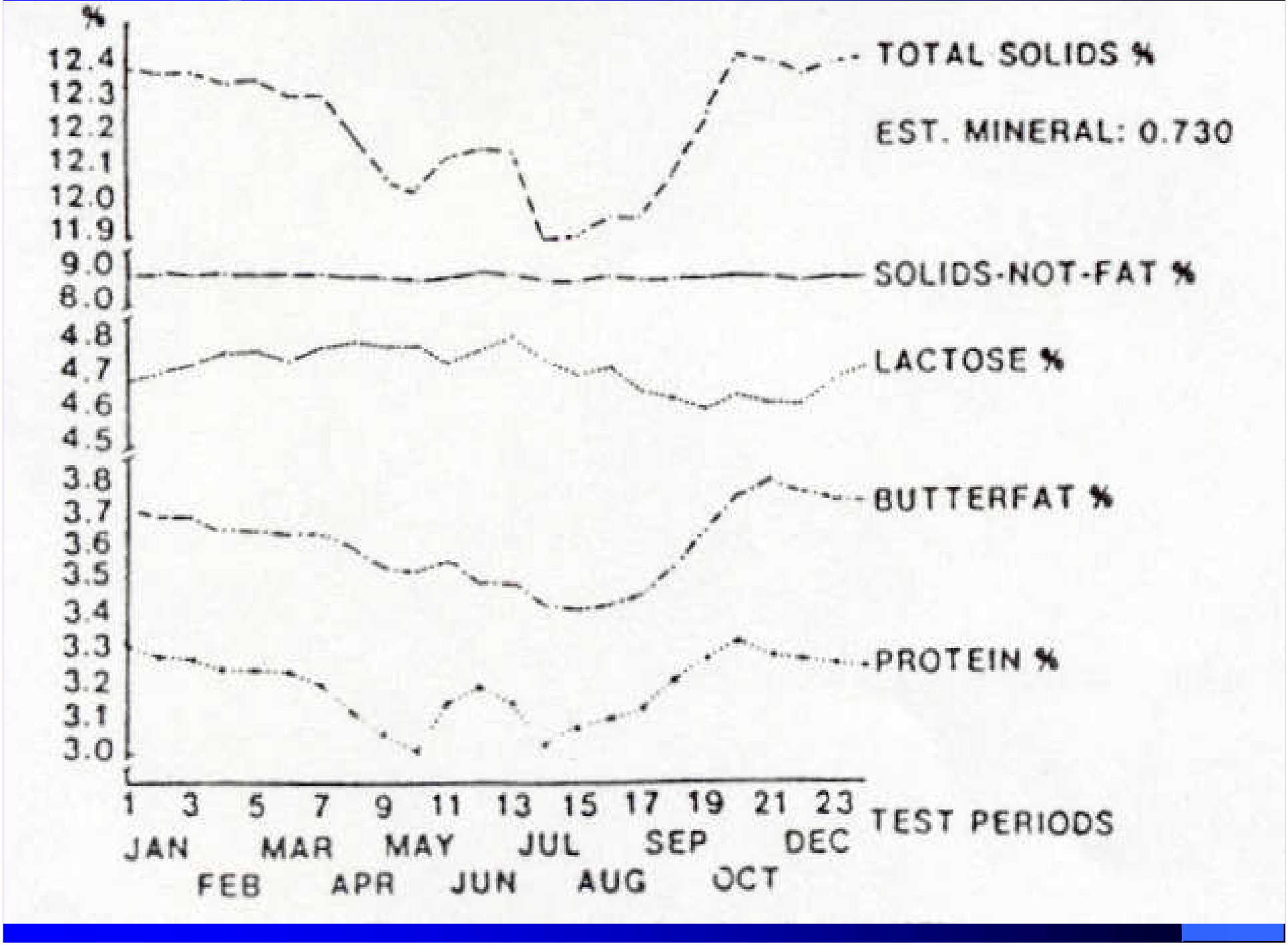
1. Different mammals produce a wide variation in composition of milk.
2. About 150 species show that dry matter content ranges from 8-65%, fat 1-53%, protein 1-19%, carbohydrate 0.1-10%, and ash 0.1-2.6%.
3. The only species raised specifically for milk production are hoofed animals, the most important of which are ruminants (cow, buffalo, goat, sheep and horse).
4. Goat and sheep milk fats have high levels of caproic, caprylic and capric acid with low contents of butyric acid .
5. Buffalo milk has comparatively large fat globules and a high colloidal phosphate content.

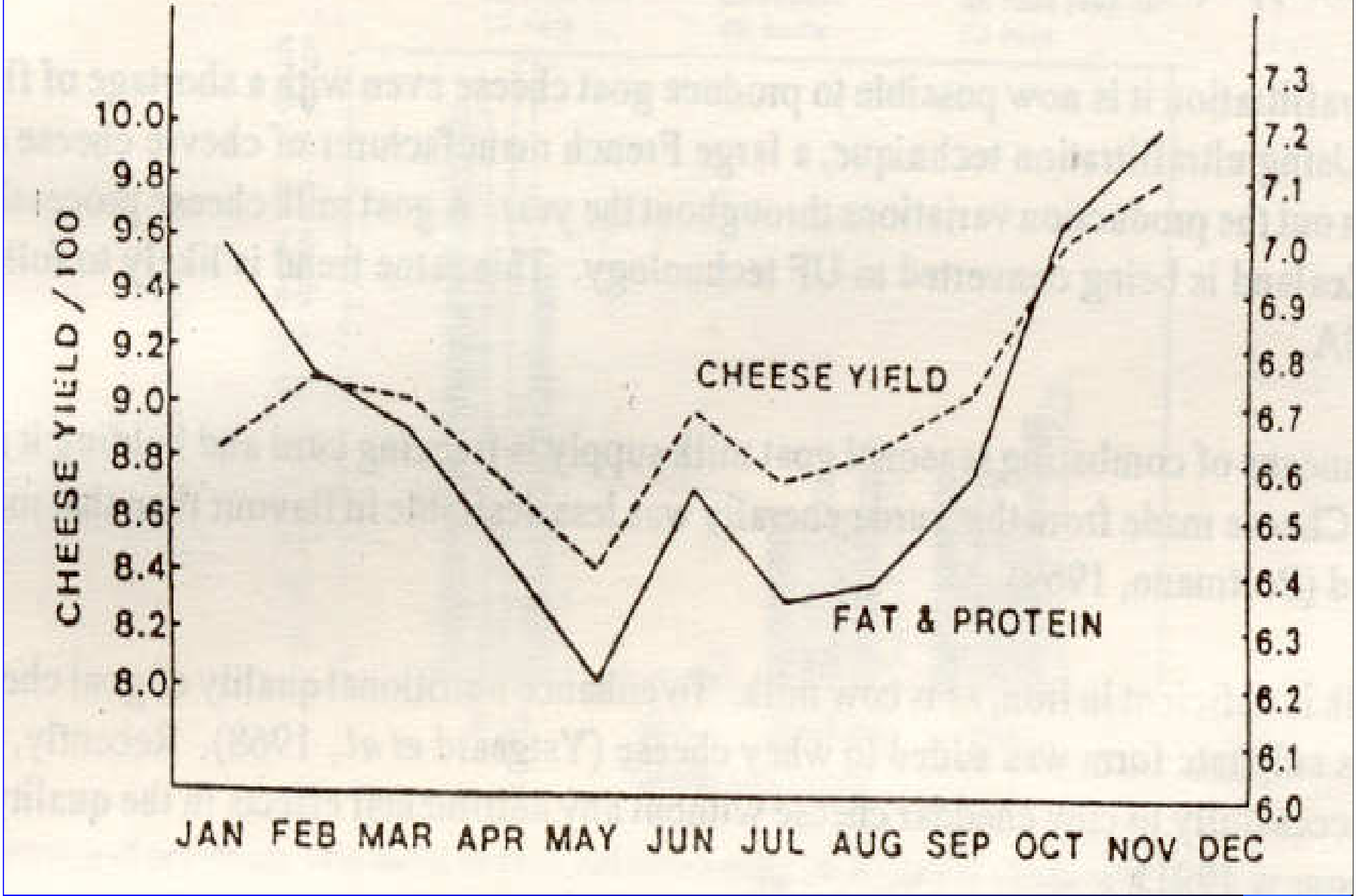
Breed

1. Breed has a significant effect on composition and yield of milk.
2. Holstein has higher milk production than Jersey, while Jersey breed milk has considerably higher solids (protein and fat) than Holstein breed.
3. In dairy goats, Saanen breed is equivalent to Holstein cow, and Nubian breed is equivalent to Jersey cow, while Alpine and Togenburg fall in between.

Stage of lactation

1. The milk production of the dairy cow at calving starts out at a relatively high level and continues to increase to a peak approximately 3-6 weeks after parturition.
2. This peak may be held for a few weeks, after which the milk production declines until the end of lactation. The rate of decline is defined as persistency.
3. The fat, solids-not-fat, and protein contents of the milk are high in early lactation, fall rapidly and reach a minimum during the 2nd and 3rd months of lactation, and then increase toward the end of lactation.
4. This causes an inverse relationship between the yield of milk and concentration of these components.
5. The lactose contents low in colostrum, increases to a high value at the beginning of lactation, and declines slightly during the remainder of the lactation.


%
12.4
12.3
12.2
12.1
12.0
11.9
9.0
8.0
4.8
4.7
4.6
4.5
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3.0
TOTAL SOLIDS %
EST. MINERAL: 0.730
SOLIDS-NOT-FAT %
LACTOSE %
BUTTERFAT %
PROTEIN %
1 3 5 7 9 11 13 15 17 19 21 23
TEST PERIODS
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT DEC


CHEESE YIELD / 100
10.0
9.8
9.6
9.4
9.2
9.0
8.8
8.6
8.4
8.2
8.0
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
6.1
6.0
CHEESE YIELD
FAT & PROTEIN
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Feed (Diet); Plane of Nutrition

1. Energy is one of the limiting factors to high milk production. Increasing the energy intake increases the level of milk production toward the animal's inherited potential.

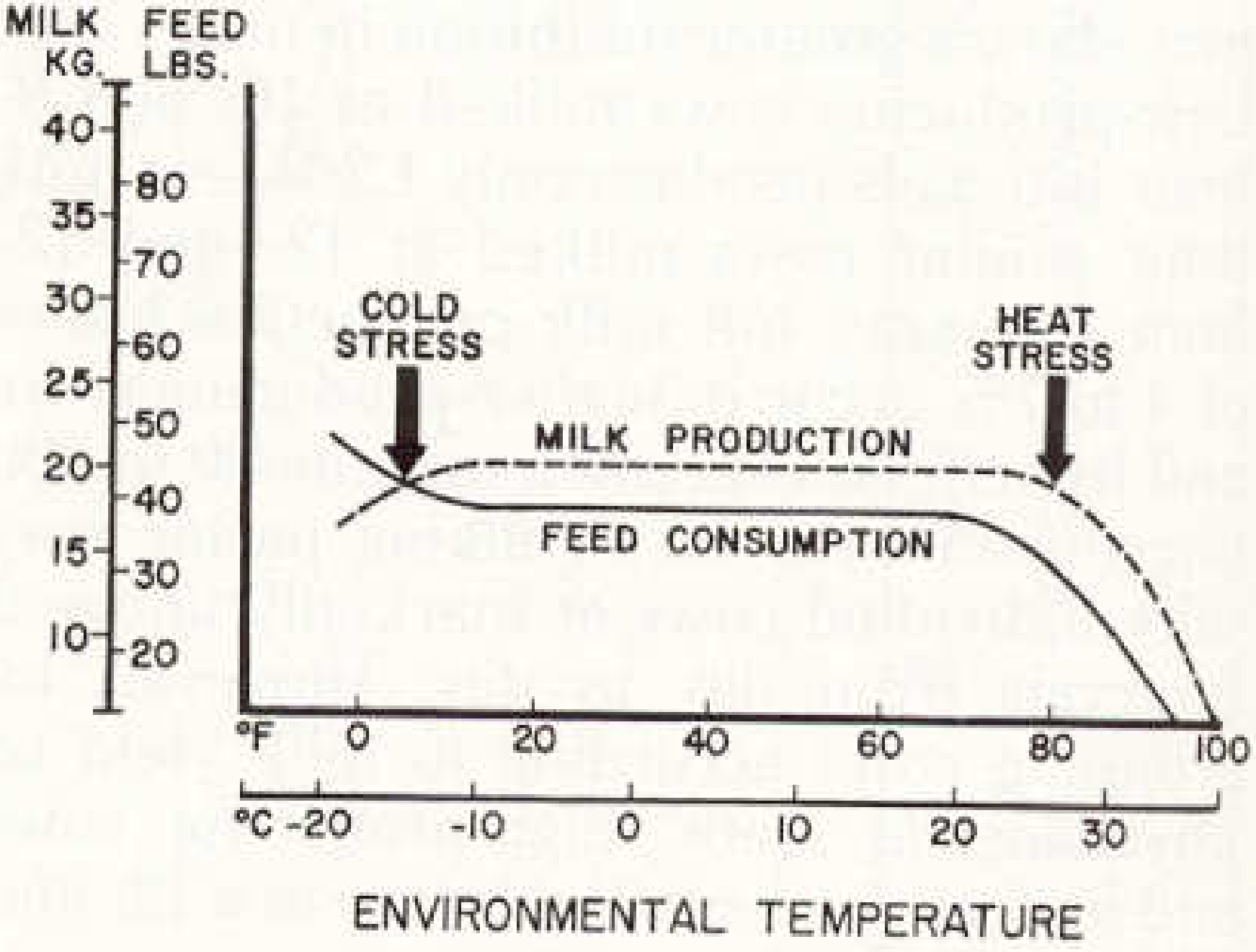
2. Severe underfeeding of protein to dairy animals causes a reduction in the SNF% of milk in addition to a drop in the milk yield.

3. Increasing the protein content above the recommended levels had no effect on yield and causes only a slight increase in NPN content in milk.

4. Feed composition can affect the fat content of milk and especially its fat composition.

5. About 3-4% fat is needed in the concentrate portion of the ration for maximum milk and fat yields.

6. The entire ration of the cow should contain at least 17% crude fiber to prevent a depression in milk fat, and physical form of the forage also plays a role in the depression of the milk fat% where fine grinding of forage causes fat depression.


MILK KG.
FEED LBS.
40
80
35
70
30
60
25
50
20
40
15
30
10
20
COLD STRESS
HEAT STRESS
MILK PRODUCTION
FEED CONSUMPTION
°F 0 20 40 60 80 100
°C -20 -10 0 10 20 30
ENVIRONMENTAL TEMPERATURE

Season

1. Cow freshening in the fall usually produce more milk than those calving in other seasons.

2. The percentage of fat and solids-not-fat are usually highest during the winter months, decline in March and April, continue to a low point in July and August, and then start to increase.

3. Fall- and Winter-freshening cows have higher % total solids, SNF, and fat than those freshening at other times of the year.

Disease

1. Mastitis affects both the yield and composition of milk; It alters the permeabilty of the udder tissue and impairs the ability of secretory tissue to synthesize milk constituents.

2. The presence of pathogenic bacteria in the udder with no clinical mastitis causes a decrease in milk yield and increases in leucocytes and somatic cell counts.

3. Milk of cows with clinical mastitis is lower in lactose and K and higher in Na and Cl than normal milk.

4. During mastitis, the globulin content increases, serum albumin and proteose contents have smaller increases and there is a decrease in the casein content.

5. Milk with a total cell count less than 100,000 cells/ml had no subclinical mastitis and no change in the chemical composition of the milk. As the cell count increased from 100,000 to 500,000 cells/ml, there was a decrease in the SNF and lactose in the milk. When the cell count was over 1,000,000/ml, the casein content began to decrease.

Environmental temperature

1. The effect of environmental temp on milk yield and composition is dependent upon the breed of animal.
2. Holsteins and the larger breeds are somewhat more tolerant of the lower temp, whereas the smaller breeds, especially the Jersey, and to some extent the Brown Swiss, are much more tolerant of the higher temp.
3. Low temp have an insignificant effect on the milk yield if extra feed is given to cover the extra energy required to maintain body temp.
4. Within the relative humidity range of 60% to 80%, the milk yield is unaffected by temp changes between 40 and 70°F.
5. Above the range of thermal neutrality, a marked decrease in milk production occurs with an increase in environmental temperature. At high temp, the food consumption decreases and the water consumption increases. At about 105°F, the food consumption and milk production approach zero.
6. The milk fat content increases with decreasing temp below 75°F. The SNF and total solids content follow the same pattern as the milk fat percent.
7. The chloride content of milk increases and the lactose decreases with high environmental temperatures.

Colostrum

1. The first-drawn milk from the mammary gland after parturition is colostrum, which is composed of milk constituents that were secreted by the mammary gland prior to parturition.
2. The total solids, protein, and ash compositions are higher in colostrums than in the normal milk.
3. The most striking difference is the high protein content in colostrums, which is largely due to the globulin content, especially γ-globulins which contain the antibodies.
4. The antibody titer of blood of the newborn calf is extremely low, where the gamma globulin can be absorbed by the calf during its first day of life.
5. After the first day, the enzymes in the intestines break down the globulin into amino acids, and thus it loses its ability to protect the animal. The loss of ability to absorb intact globulins after the first day may be due to changes in the absorptive ability of the intestine.
6. Colostrum contains a lower lactose content than normal milk, and high levels of lactose can cause scours in claves.
7. Colostrum is higher in Ca, Mg, P, and Cl, and lower in K than normal milk.
8. The vitamin A content of colostrums is about 10 times higher than normal milk.

Age and body weight at calving

1. The amount of milk production in cow increases with advancing age.

2. Part of this increase is due to an increase in body weight, which results in a larger digestive system and a larger mammary gland for the secretion of milk.

3. Advancing age or increased number of lactations results in a gradual decrease in the percent milk fat and solids-not-fat.

4. The drop in fat content is about 0.2% from the first to fifth lactations and that for solids-not-fat is about 0.4%. Beyond the 5th lactation there are little changes.

5. Much of the drop in the solids-not-fat is due to a drop in lactose content, whereas the change in the total protein content is relatively small.

6. The % composition of casein decreases, which must result in a compensatory increase in the noncasein protein content.

7. Milk production increases between 100 to 870 lb for each 100-lb increase in body weight when age is held constant.