

# Benefits of Goat Milk and Its Products in Human Nutrition and Wellbeing

Young W. Park

Georgia Small Ruminant Research and  
Extension Center

Fort Valley State University  
Fort Valley, Georgia 31030

And

Dept. of Food Science & Technology  
University of Georgia, GA 30602 U.S.A.



# Goat Products-St. Helens Farm, UK







## Summary of Annual Milk Production in the World (1000 tonnes)

Region	Cow	Sheep	Goat	Buffalo	Total
Africa	12,523	1,512	1,990	1,420	17,445
North America	85,184	-	345	-	85,529
South America	29,119	39	153	-	29,311
Asia	48,820	3,665	3,787	36,743	93,015
Europe	172,557	3,716	1,663	94	178,030
Oceania	14,209	-	-	-	14,209
USSR	105,950	86	360	-	106,396
World					
Year 1988	468,362	9,017	8,299	38,257	523,935
% of the world	89.39	1.73	1.58	7.30	100
Year 1997	471,794	8,385	10,592	55,873	546,644
% of the world	86.31	1.53	1.94	10.33	100
Year 2001	493,828	7,808	12,445	69,248	583,339

# Significance of Goat Milk

- Although dairy cows produce the highest amount of the world milk supply mostly in developed countries, more people drink the milk of goats than milk of any other species worldwide.
- Due to the unavailability of cow milk, goat milk and its products are important daily food sources of protein, phosphate and calcium for the people of developing countries.
- Dairy goat farming is a vital sector of agriculture in developed countries especially in the Mediterranean region such as France, Italy, Spain, and Greece.
- This may prove that goat and sheep dairying is not necessarily synonymous with poverty or an underdeveloped business sector.

# Significance of Goat Milk

- **Although goats produce only about 2% of the world's total milk supply, goat milk and its products have provided humanity with vital lines of nutritional and economic survival and wellbeing around the world.**
- **Production of goat milk is immensely important in underdeveloped countries, where it provides basic nutrition and subsistence to the majority of their populations residing in rural areas.**
- **Moreover, goat milk and its products have been increasingly popular in developed countries because of the recent trend in demand for health foods as well as hypoallergenic foods for those who suffer from cow milk allergy.**

# Significance of Goat Milk

- **Goat milk differs from cow or human milk in higher digestibility, distinct alkalinity, higher buffering capacity, and certain therapeutic values in human medicine.**
- **Goat milk has higher digestibility than cow milk, because it has smaller fat globules size (naturally homogenized), and more friable milk proteins when acidified due to very low  $\alpha_{s1}$ -casein and higher  $\alpha_{s2}$ -casein, compared to cow milk.**
- **Goat milk has more short and medium chain fatty acids (MCT), which have the unique metabolic ability to provide energy in growing children, and are used for treatment of lipid malabsorption patients.**



# Significance of Goat Milk

- **Goat milk and its manufactured products including cheeses, yoghurt and powdered products are valued parts of the dairy industry in developed countries.**
- **Goat milk provides connoisseur consumers with diversified and unique tastes, and supports people with medical afflictions, such as allergies and gastro-intestinal disorders, who need alternative dairy products.**
- **Therefore, goat milk serves human nutrition in three important ways: (a) home consumption, (b) specialty gourmet interests, and (c) medical-therapeutic applications.**



# Queso Manchego Sheep Cheese (Areas of Production in Spain)







## Total milk production of goat milk in the period of 1980-2001 and relative proportion for each continent

Year	1980 1,000 MT	2001 1,000 MT	Change, % 2001 – 1980	World, % 1980	World, % 2001
<b>World</b>	<b>7,236</b>	<b>12,455</b>	<b>+ 72</b>	<b>100</b>	<b>100</b>
Africa	1,477	2,773	+ 88	20	22
N.C.America	318	165	- 48	4	1
S.America	134	182	+ 36	2	1
Asia	3,435	7,017	+ 104	48	56
Europe	1,569	2,317	+ 48	22	19

(FAO, 1986, 2002)

## Trends of populations of goats and people during the last 20 years (1980-2001; FAO, 1986, 2002)

	1980	2001	Change, % 2001 - 1980
<b>GOATS (Million head)</b>			
World	458	738	+ 61
Africa	149	219	+ 47
N.C.America	13	14	+ 8
S.America	19	22	+ 16
Asia	258	465	+ 80
Europe	12	18	+ 50
Mediterranean region	44	40	- 9
Oceania	0.4	0.7	+ 75
<b>PEOPLE (Million head)</b>			
World	4,450	6,134	+ 38
Africa	480	812	+ 69
N.C. America	373	493	+ 32
S. America	240	351	+ 46
Asia	2,584	3,721	+ 44
Europe	484	726	+ 50
Oceania	23	31	+ 35

## Total milk production by species in the period of 1980-2001 and relative proportion for each continent within species.

Year	1980	2001	Change, %	World, %	World, %
	1,000 MT	1,000 MT	2001 -1980	1980	2001
Goats	7,236	12,455	+ 72	100	100
Sheep	7,980	7,808	- 2	100	100
Buffalo	27,491	69,248	+ 152	100	100
Cow	423,034	493,828	+ 17	100	100
All milk	465,741	583,339	+ 25	100	100

(FAO, 1986, 2002)



## Comparative Average Composition of Milk

Composition	Goat	Cow	Human
Fat, %	3.8	3.6	4.0
Solid-not-fat, %	8.9	9.0	8.9
Lactose, %	4.1	4.7	6.9
Protein, %	3.4	3.2	1.2
Casein, %	2.4	2.6	0.4
Albumin, globulin, %	0.6	0.6	0.7
Non-protein N, %	0.4	0.2	0.1
Ash, %	0.8	0.7	0.3
Calcium (CaO), %	0.19	0.18	0.04
Phosphorus (P <sub>2</sub> O <sub>5</sub> ), %	0.27	0.23	0.06

(Haenlein and Caccese, 1984)

# Comparison of Nitrogen and Casein Contents between Goat and Cow Milk<sup>a</sup>

N and Casein Milk)	Goat Milk	Cow Milk <sup>b</sup>	Range (Goat
<b>Compounds</b>			
Total N (g/l)	27.2	32.0	19.1 – 33.6
Casein (g/l)	21.1	27.0	15.8 – 26.0
Non-protein N (%)	6.3	4.5	3.1 – 13.2
Casein (% of total)			
$\alpha_{s1}$	5.6	38.0	0 – 20
$\alpha_{s2}$	19.2	12.0	10 – 30
$\beta$	54.8	36.0	43 – 68
$\kappa$	20.4	14.0	15 – 29
$\alpha$ -Lactalb/ $\beta$ -Lactogl	0.63	0.4	0.33 -1.1

<sup>a</sup>Reneuf and Lenoir, IDF Bull, No. 202:69, 1986

<sup>b</sup>Friesian-Holstein cows

## Average amino acid composition (g/100 g milk) in proteins of goat and cow milk<sup>a,b</sup>

	Goat milk	Cow milk	Difference (%) for goat milk
Essential amino acids			
Tryptophan	0.044	0.046	
Threonine	<b>0.163</b>	<b>0.149</b>	<b>+9</b>
Isoleucine	<b>0.207</b>	<b>0.199</b>	<b>+4</b>
Leucine	0.314	0.322	
Lysine	<b>0.290</b>	<b>0.261</b>	<b>+11</b>
Methionine	0.080	0.083	
Cystine	<b>0.046</b>	<b>0.030</b>	<b>+53</b>
Phenylalanine	0.155	0.159	
Tyrosine	<b>0.179</b>	<b>0.159</b>	<b>+13</b>
Valine	<b>0.240</b>	<b>0.220</b>	<b>+9</b>

<sup>a</sup>Posati and Orr (1976)

<sup>b</sup>Arranged by Haenlein (2004)

## Cholesterol and Fatty Acid composition of Different Species Milks<sup>a,b</sup>

Species	Fatty Acids (g/100g)			Cholesterol (mg/100g)
	Saturated	Monounsaturated	Polyunsaturated	
<b>Cow milk</b>				
Whole	2.4	1.1 (0.96) <sup>c</sup>	0.1	14
Skim	0.1	Tr	Tr	2
Dried whole	16.5	7.6	0.8	120
<b>Goat milk</b>	<b>2.3</b>	<b>0.8 (1.11)<sup>c</sup></b>	<b>0.1</b>	<b>10</b>
Sheep milk	3.8	1.5	0.3	11
<b>Human milk</b>				
Colostrum	1.1	1.1	0.3	31
Mature	1.8	1.6	0.5	16
Soya milk	0.3	0.4	1.1	0

<sup>a</sup>Date taken and organized from Holland et al. (1989).

<sup>b</sup>Park and Guo (2006).

<sup>c</sup>USDA Handbook No. 8-1 (Posati and Orr, 1976).

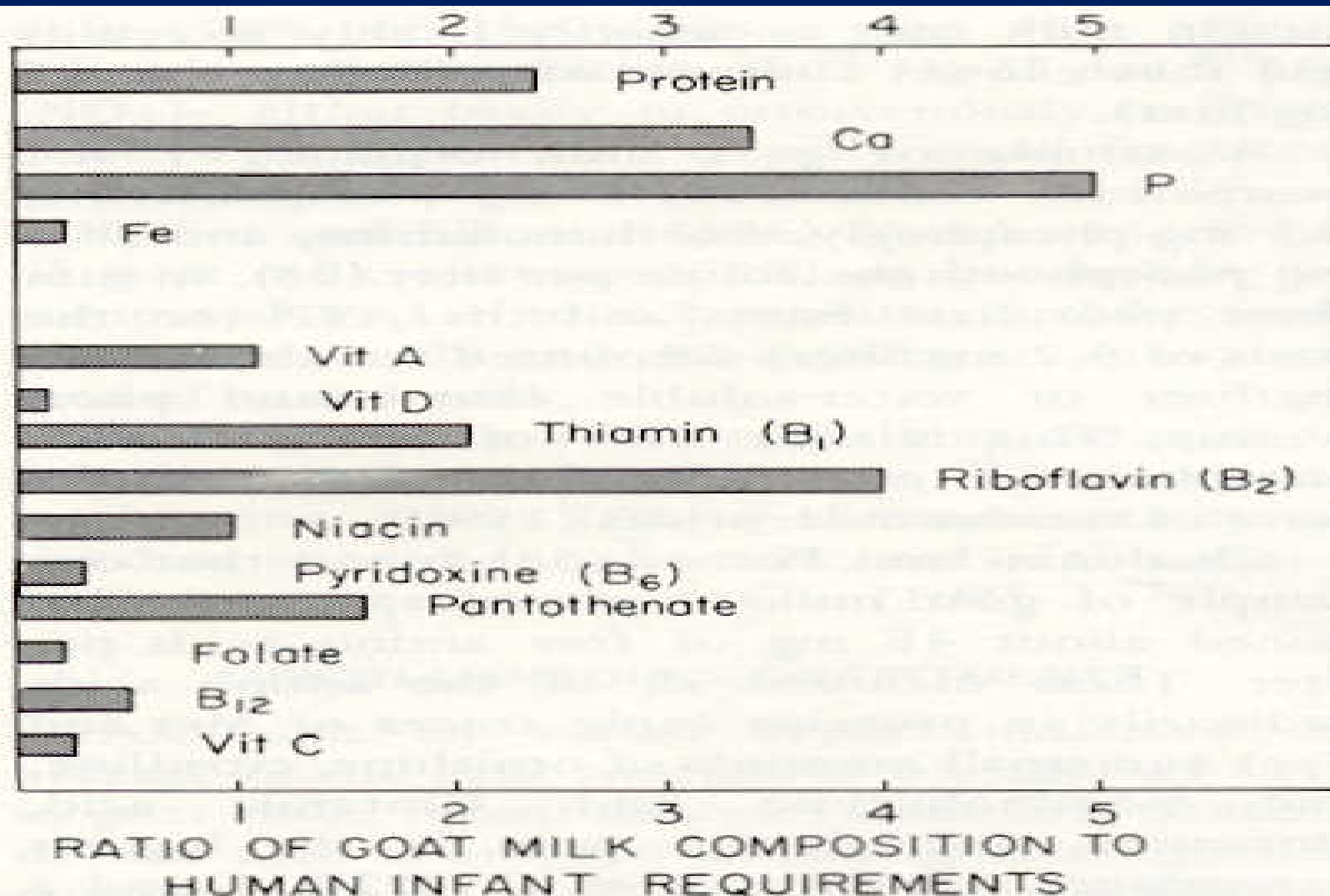
## Basic nutrient contents (%) of commercial U.S. goat milk products (wet basis)

Goat Milk Product	Total Solids		Protein		Fat		Carbohydrate		Ash	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	X	SD
	<b>Fluid Milk</b>									
Recent Study <sup>a</sup>	11.3	0.05	2.92	0.09	3.40	0.10	4.15	0.13	0.79	0.01
USDA <sup>b</sup>	13.0	0.15	3.56	0.03	4.14	0.05	4.45	-	0.82	0.01
<b>Evaporated Milk</b>										
Recent Study <sup>a</sup>	20.85	0.05	6.11	0.33	6.75	0.05	6.56	0.53	1.43	0.10
USDA <sup>c</sup>	25.86	0.08	6.81	0.03	7.56	0.01	10.04	-	1.55	0.02
<b>Powdered Milk</b>										
Recent Study <sup>a</sup>	94.1	0.56	27.0	0.45	28.2	1.35	32.0	0.33	6.77	0.15
USDA <sup>d</sup>	97.5	0.13	26.3	0.18	26.9	0.25	38.4	-	6.08	0.09
<b>Yogurt<sup>e</sup></b>										
Plain	11.5	2.56	3.99	0.12	2.25	0.13	4.49	0.56	0.82	0.02
Blueberry	17.7	2.34	3.37	0.13	1.18	0.17	12.6	2.72	0.86	0.09
<b>Cheese<sup>f</sup></b>										
<b>Soft</b>										
Plain	40.2	6.81	18.9	5.26	22.5	4.37	-	-	1.74	0.97
Herb	40.9	2.11	17.3	2.26	21.8	2.13	-	-	1.60	0.61
<b>Hard</b>										
Cheddar	58.3	1.76	30.3	0.56	26.6	1.13	1.40	-	3.60	0.13
Blue	74.1	1.62	20.2	0.35	31.8	1.06	-	-	3.32	0.36

<sup>bcd</sup>Data for fluid goat milk from *USDA Handbook No. 8-1* (1976).

<sup>aef</sup>Park (1990, 1994, 2000).

# Nutrients in goat milk in relation to requirements of human infants (Jenness, 1980).



# Symptom of Milk Protein Allergy

---

## Gastrointestinal

Vomiting

Diarrhea

Colitis

Abdominal pain

Malabsorption

## Dermatologic

Eczema

Urticaria

Angioedema

## Respiratory

Rhinitis/rhinorrhea

Otitis media

Asthma

Cough

Bronchitis

## Systemic

Anaphylaxis

Irritability

Hyperactivity

Failure to thrive

McClenathan and Walker (1982)



## Why Sensitization to Milk?

### Volume



The relatively large volume of cow's milk an infant's immature intestinal tract must digest is one reason for frequent sensitization to milk in infancy. Reprinted with permission of The Williams and Wilkins Co., Baltimore. Deamer W: Recurrent abdominal pain. *Curr Med Dialog* 40:130, 1973



## Variation in Skin Test Reactions to Fractions of Cow Milk and Goat Milk

Patients	$\alpha$ -lactalbumin	$\beta$ -lactalbumin	Casein	Bovine plasma albumin	Goat milk albumin
GF	++++	+	--	--	--
VWW	++	+	--	--	--
DK	+	++++	+	--	--
VDB	++++	+++	+++	not done	+++

Perlman (1977)



# Comparison of average size fat globules in milk of goats, buffaloes, cows, and sheep

Diameter ( $\mu\text{m}$ )	Goat	Cow	Buffalo	Sheep
	----- (%) -----			
1.5	28.4	10.7	7.9	28.7
3.0	34.7	32.6	16.6	39.7
4.5	19.7	22.1	16.4	17.3
6.0	11.7	17.9	20.3	12.1
7.5	4.4	12.2	20.9	2.0
9.0	1.0	3.1	10.5	0.2
10.5	0.2	1.4	1.7	...
12.0	...	0.1	2.0	0.1
13.5	...	...	0.4	...
15.0	...	...	0.3	...
16.5	...	...	...	...
18.5	...	...	0.1	...
<b>Average</b>	<b>3.49</b>	<b>4.55</b>	<b>5.92</b>	<b>3.30</b>

Fahmi et al. (1956)

# Short and Medium Chain Fatty Acids (MCT)

## Used for

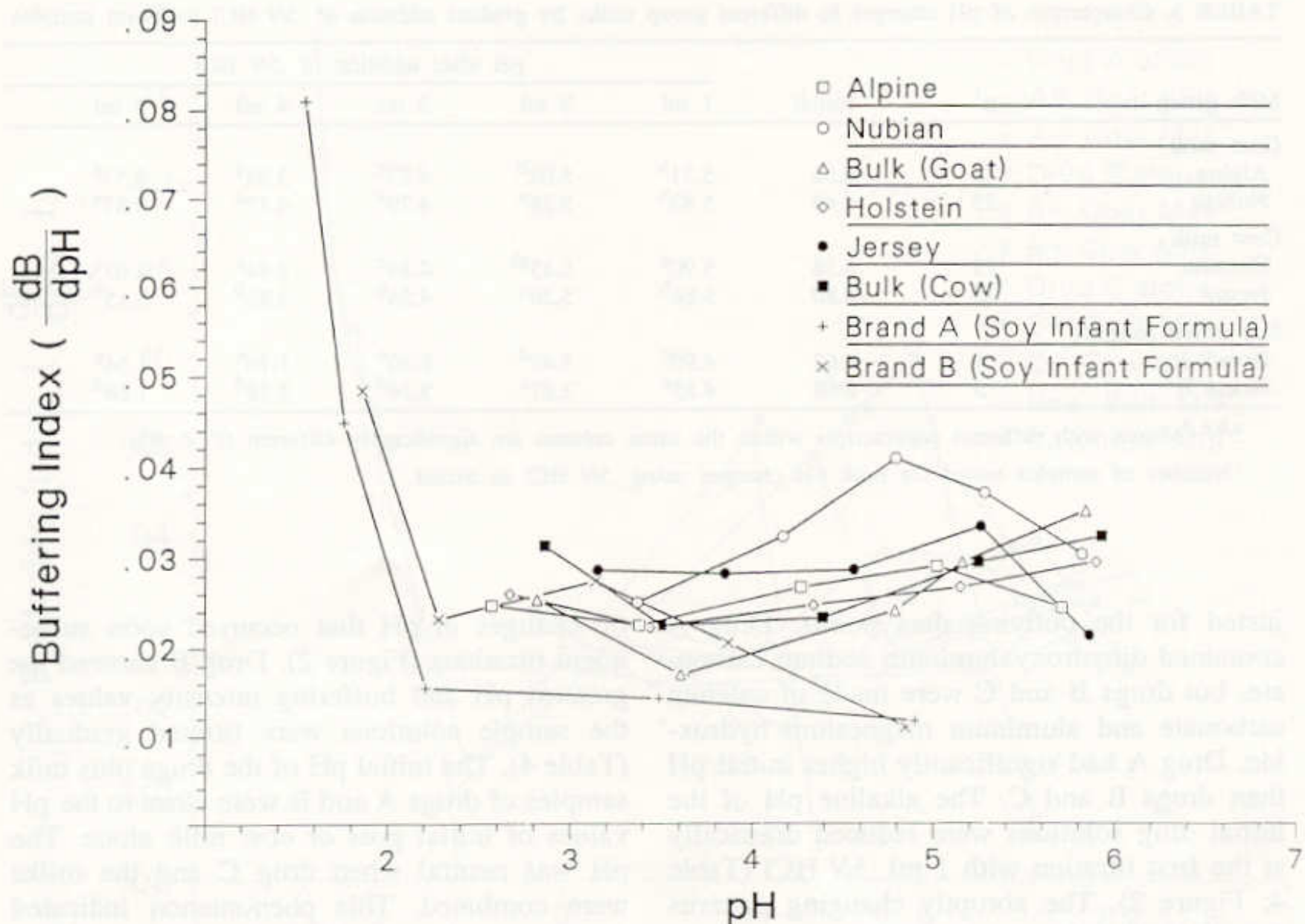
1. Treatment of malabsorption patients; Chyluria, Steatorrhea, Coronary bypass Hyperlipoproteinemia, Premature infant feeding, Childhood epilepsy, Cystic fibrosis, and Gallstones
2. Providing metabolically unique energy to growing children.
3. Hypocholesterolemic effects on tissues via inhibition of cholesterol deposition and dissolution of cholesterol in gallstones.

## Concentration of Total N, NPN, and phosphate in Goat and Cow Milk and soy-based Infant Formulas

Milk group	N	Total N		NPN		P <sub>2</sub> O <sub>5</sub>	
		X	SD	X	SD	X	SD
Goat Milk							
Alpine	25	.390	.032	.048	.008	.166	.020
Nubian	25	.556	.013	.061	.013	.212	.015
Cow Milk							
Holstein	25	.392	.058	.033	.002	.173	.022
Jersey	25	.505	.043	.038	.004	.211	.118
Formula Milk							
Brand A	5	.227	.026	.020	.003	.211	.008
Brand B	5	.259	.016	.019	.003	.192	.053

Park (1991)

# Comparison of Buffering Capacity among different milks



## Some Advantages of Goat Milk compared to Cow Milk

- Goat milk has higher buffering capacity, which would be beneficial for treatment of stomach ulcers (Park, 1994; Park and Haenlein, 2006).
- Symptoms of cow milk allergy (CMA) are manifested as vomiting, diarrhea, colitis, epigastric distress, malabsorption, eczema, urticaria, rhinitis, asthma, bronchitis, erythema, anaphylaxis, hyperactivity, migraine, etc. (Husby et al., 1990; Park, 1994).
- Goat milk with the genetic trait of low or no  $\alpha_{s1}$ -casein, but instead with  $\alpha_{s2}$ -casein, has less curd yield, longer rennet coagulation time, more heat lability, and weaker curd firmness, which also may explain the benefits in digestibility in human digestive tract (Ambrosoli et al., 1988; Haenlein, 2004).

# Some Advantages of Goat Milk compared to Cow Milk

- Only one in 100 infants who were allergic to cow milk, did not thrive well on goat milk (Walker, 1965 ): From 1682 allergic migraine patients, 1460 foods; 98 inhalants; 98 endogenous (bacterial) substances, and 25 drugs (including tobacco). Among the 1460 patients with food allergy, 92% due to cow milk or dairy products; 35% wheat; 25% fish; 18% egg; 10% tomato; 9% chocolate.
- In a French extensive clinical studies with children allergic to cow milk, 93% of the children had positive results and goat milk was recommended as a valuable aid in child nutrition, because of less allergenicity and better digestibility than cow milk (Fabre,1997; Reinert and Fabre, 1997 ).

# Some Nutritional Studies

## 1. **Goat milk exhibits higher nutrient bioavailability:**

In a nutrition trial with 38 children (20 girls and 18 boys) aged 6 to 13 years, half of them fed 0.946L goat milk, and the other half fed 0.946L cow milk/day for 5 months. Results showed that children fed goat milk surpassed those fed on cow milk in: weight gain, stature, skeletal mineralization, bone density, blood plasma vitamin A, calcium, thiamine, riboflavin, niacin and hemoglobin concentrations (Mack, 1953) .

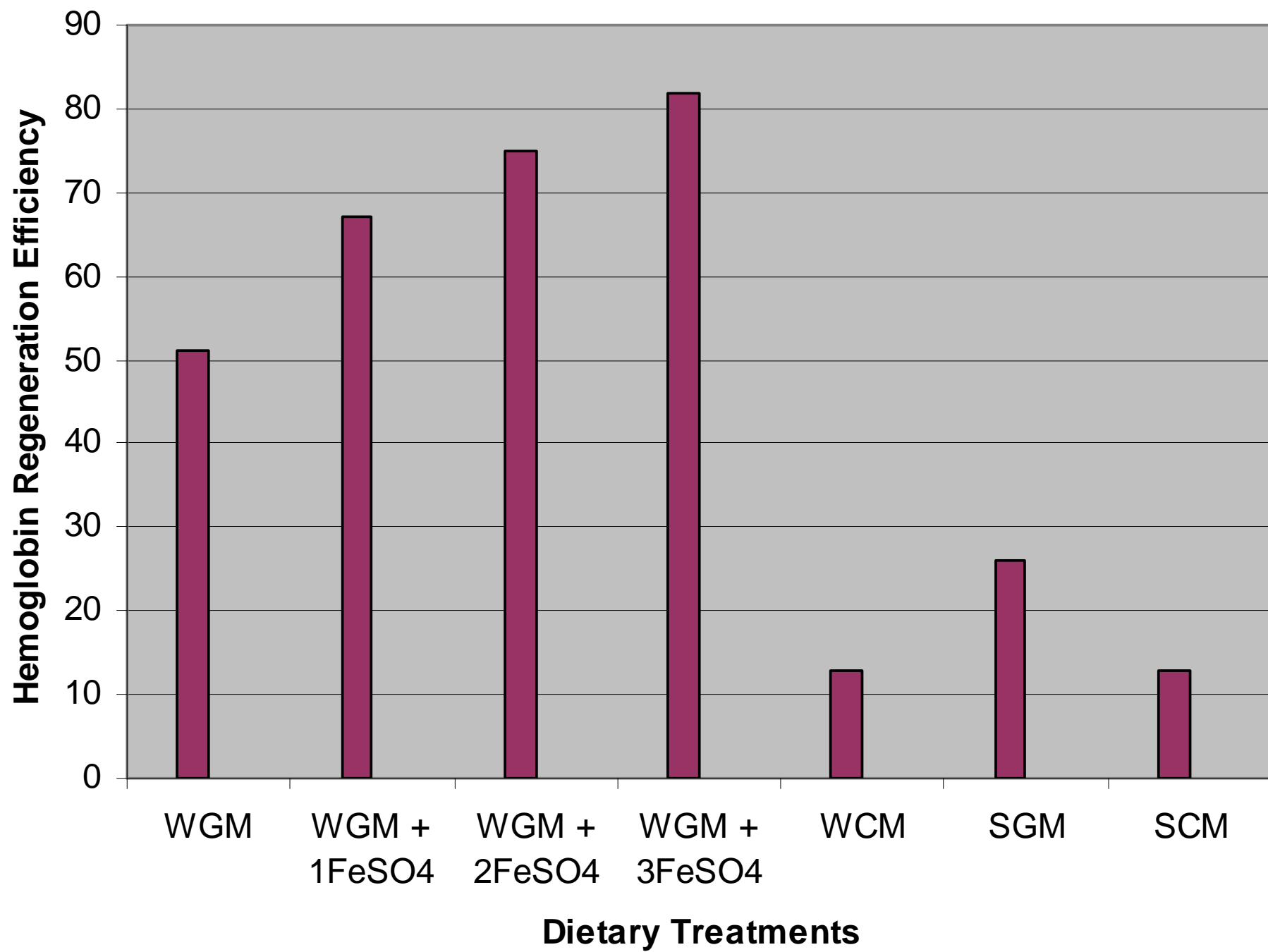
## 2. **Goat milk showed higher iron bioavailability:**

Rats fed on goat milk grew significantly better, had higher liver weights, hemoglobin regeneration efficiency, and higher iron absorption rates than those on cow milk (Park et al., 1986) .

## 3. **Goat milk has hypocholesterolemic effect:**

Goat milk reduced total cholesterol levels and the LDL fraction, because of the higher presence of medium-chain triglycerides (MCT), which decreases the synthesis of endogenous cholesterol by 36% in goat milk vs. 21% in cow milk (Alferez et al., 2001).





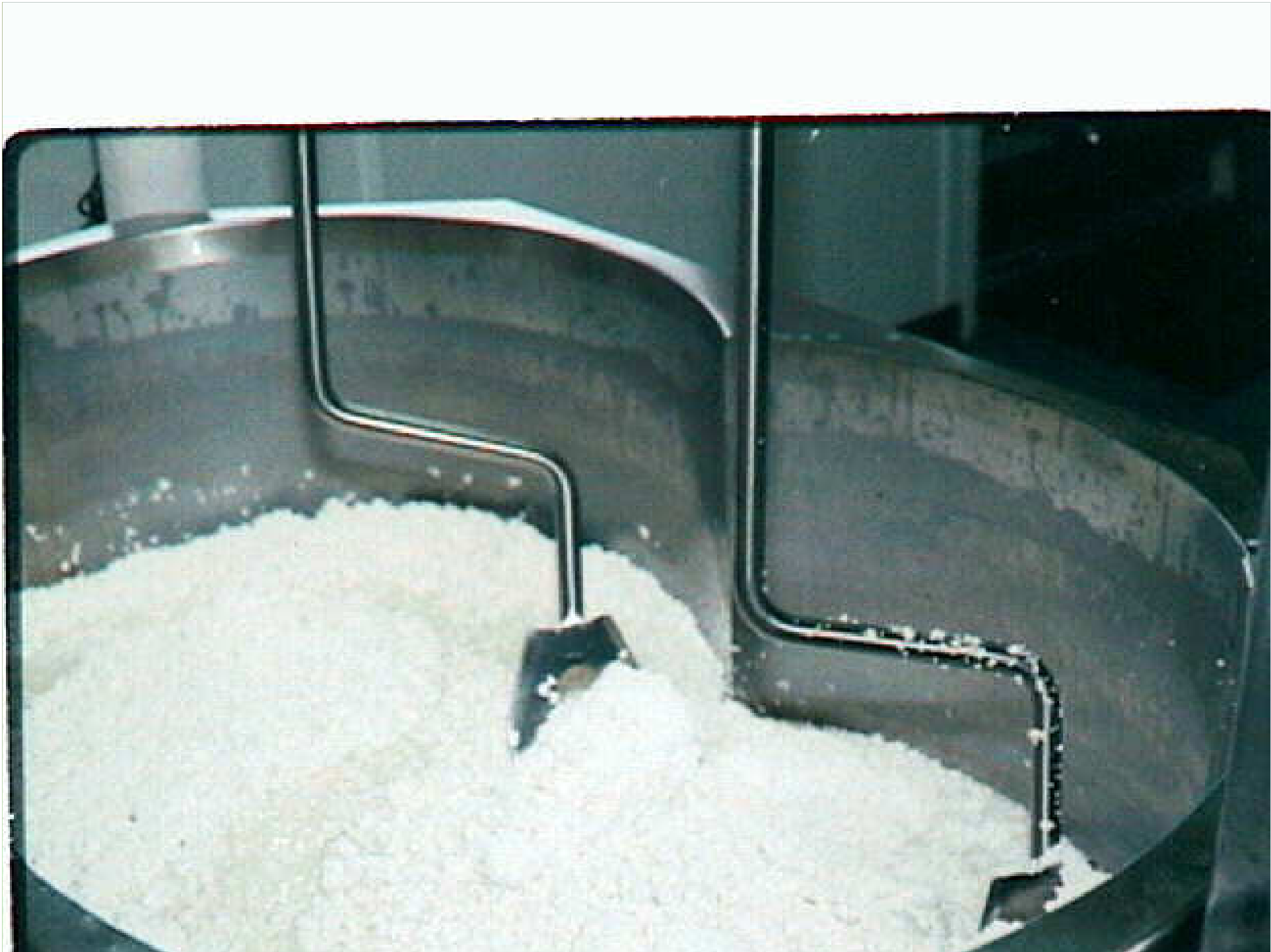
# Challenge of the Dairy Goat Industry

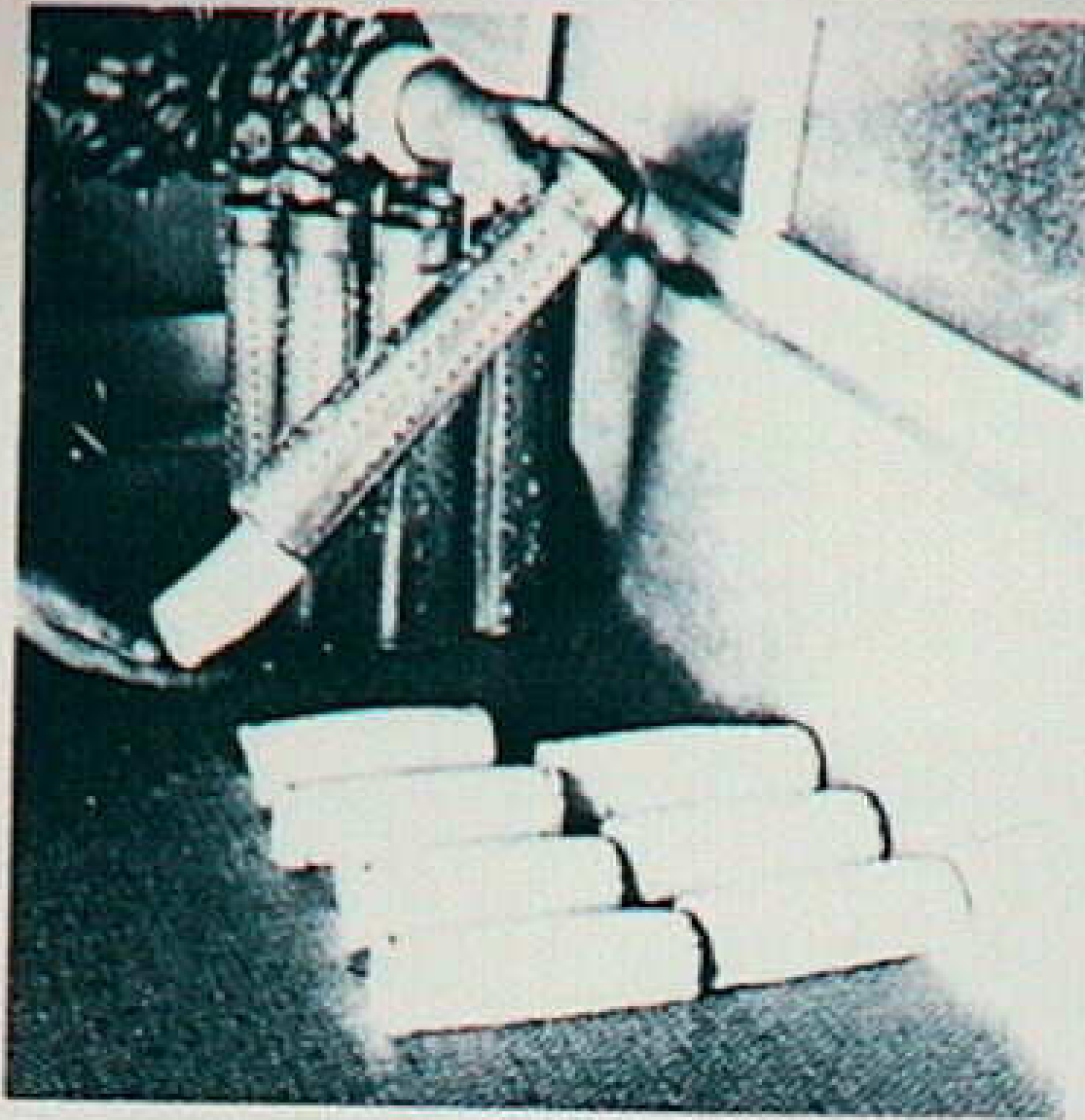
- Seasonal milk supply
- High somatic cell counts in goat milk
- Maligned image of goat milk and its products to consumers.
- Development of superior quality dairy goat products attractive to the consumers.



## Moisture Content and Yield of Goat Milk Cheeses

Type of cheese	Moisture content	Cheese yield (kg/100kg milk)
Very fresh	80%	18 kg of above
Fresh	62%	14.5 - 15 kg
Semi-dry	58%	12.5 kg
Ripened	55%	11 -12 kg
Dry	50%	10.5 kg
Uncooked pressed body	52%	8.5 - 10 kg






Unmoulding (Le Démoulage) is a delicate operation.

# Technical Approach to solve Seasonal Milk Supply

- Ultrafiltration
- Freezing curds
- Storage of frozen curd and cheese
- Spray drying (manufacturing evaporated and powdered milk)
- Production of mixed cheeses

# MARKETING STRATEGIES FOR ENHANCING DAIRY GOAT INDUSTRY

1. Consumer perception of safety and nutrition.
  2. Quality of flavor, body texture and appearance.
  3. Availability of specialty type cheeses.
  4. Attractiveness of packaging
  5. Relative price of goat milk products.
  6. Establishment of proper distribution and marketing channels.
  7. Continuous promoting activities for goat cheeses and products toward consumers.
- 

# SUMMARY

- 1. Goat milk plays an immensely important role in underdeveloped countries, where it provides basic nutrition and subsistence to the majority of their populations.**
- 2. Goat milk and its products are also increasingly popular in developed countries, where they provides connoisseur consumers with diversified and exotic tastes, as well as people having medical afflictions, such as cow milk allergies and gastro-intestinal disorders with health and therapeutic alternative foods.**
- 3. Goat milk serves human nutrition basically 3 important ways: (a) home consumption, (b) specialty gourmet interests, and (c) medical-therapeutic applications.**



# SUMMARY

4. GM has been recommended as an ideal substitute for infants and patients who suffer from cow milk allergy.
5. GM has higher digestibility than cow milk due to smaller fat globule size than cow milk, and also protein forming soft and more friable curd when acidified.
6. GM has higher buffering capacity which is good for treating stomach ulcers.
7. GM has higher iron bioavailability (Park et al. 1986), and gave higher body growth and bone mineralization in children compared to cow milk (Mack, 1953).
8. GM has higher protein and mineral, and an important source of protein, calcium and phosphate in under-developed countries due to unavailability of cow milk.

# SUMMARY

9. GM has higher levels of short and medium chain fatty acids (MCT), which have the unique metabolic ability to provide energy in growing children, and also been used for treatments of many clinical malabsorption disorders in infants and adult human patients.
10. Cholesterol levels of normal fluid goat, cow, sheep and human milk are 10, 14, 11, 16 mg/100g, indicating that goat milk has the lowest cholesterol level among these 4 species milks.
11. Goat milk has adequate amounts of vitamin A and niacin, and excesses of thiamin, riboflavin and pantothenate for a human infant, while deficient in vitamin B<sub>6</sub>, B<sub>12</sub>, folic acid, C and D.

THANK YOU!!

