SAVOUR EXCELLENCE

Happy Days Dairies Ltd.

Article #7 - Properties and Health Benefits of Fermented Dairy Products

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Properties and Health Benefits of Fermented Dairy Products
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Goat milk is a nutritional and therapeutic food. The unique and beneficial characteristics of this dairy alternative that are superior to cow milk have been previously discussed, and include: better digestibility, greater buffering capacity, fat globules that are smaller in diameter and better distributed in the milk emulsion, higher content of short-chain fatty acids in the milk fat, higher content of zinc, iron and magnesium, stronger lactoperoxidase (antimicrobial) system as well as better immunological and antibacterial properties. The greater amounts of certain minerals such as calcium, zinc and magnesium in goat milk may also influence and facilitate the growth of lactic acid bacteria as they are a normal part of some enzymatic complexes involved in the fermentation of lactose. Furthermore, the higher whey protein content could also be significant because *Lactobacillus acidophilus* and *Bifidobacteria* grow more readily in the presence of higher levels of some amino acids. Fermentation is known to amplify the existing beneficial properties of dairy products, and fermented goat milk alternatives have been shown to have great health advantages, including anti-allergenic, probiotic and anti-carcinogenic. It has also been shown that nutritive value of goat milk increases during fermentation and that it loses its characteristic "goaty" taste, which is unacceptable to many consumers (Slancanac et al., 2010).

Fermentation & End Products

Food spoilage caused by microorganisms was an important problem throughout human history. Finding ways to overcome this issue became increasingly necessary as communities expanded and not everyone produced their own food. As a result, preservation methods such as salting, drying, canning and pasteurization were developed in order to delay food spoilage. Fermentation was also discovered early on to be a good method for preservation by using the growth of certain microorganisms in food as an advantage. The fermentation process has been shown to increase the nutritive value of dairy products. **Table** 1 shows the increase in various components in cow and goat milks, demonstrating that the latter contains higher amounts of beneficial organic acids both before and after fermentation.

Table 1. Organic acid production during fermentation of goat and cow milks

		Fermentation time/hours		
Milk	*Fatty acid*	*0*	*12*	*24*
Caprine	Butyric	3.44[a] ± 0.18b[b]	3.46 ± 0.06b	3.86 ± 0.35c
Bovine		2.90 ± 0.04a	3.27 ± 0.12b	3.78 ± 0.14c
Caprine	Caproic	2.32 ± 0.03b	2.39 ± 0.2b	3.27 ± 0.22c
Bovine		1.09 ± 0.1a	1.15 ± 0.0a	1.05 ± 0.06a
Caprine	Caprylic	3.47 ± 0.05b	3.76 ± 0.29b	6.95 ± 0.22c
Bovine		0.67 ± 0.16a	0.85 ± 0.08a	0.75 ± 0.14a
Caprine	Capric	9.03 ± 0.38b	9.65 ± 0.04c	11.21 ± 0.31d
Bovine		2.31 ± 0.02a	2.36 ± 0.14a	2.32 ± 0.07a
Caprine	Lauric	6.77 ± 0.15b	7.01 ± 0.07b	8.31 ± 0.38c
Bovine		2.46 ± 0.25a	2.54 ± 0.25a	2.42 ± 0.07a
Caprine	Myristic	12.57 ± 0.04d	12.18 ± 0.28cd	21.20 ± 0.35e
Bovine		10.15 ± 0.27a	11.76 ± 0.35bc	11.33 ± 0.16b

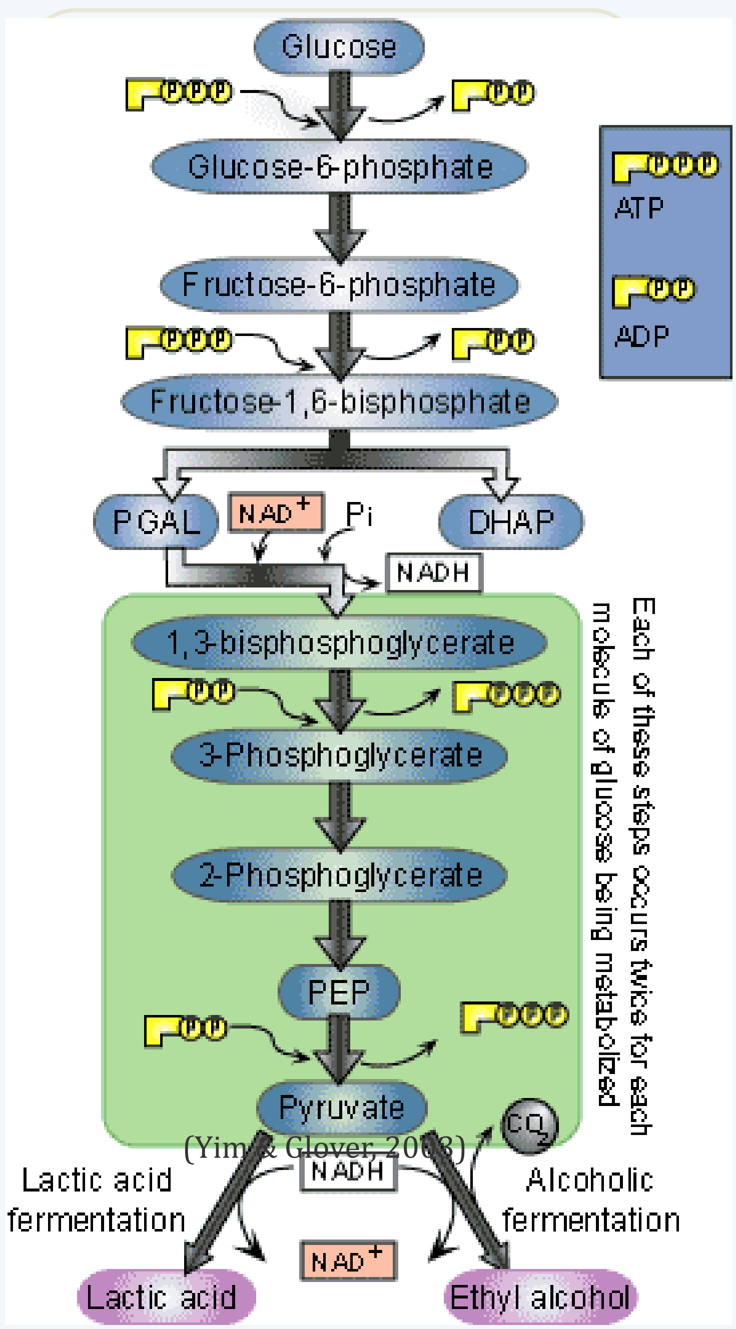
[a]Mean ± standard deviation, $n = 5$.
[b]Mean values followed by the same letter in the same column and in the same row are not significantly different ($P < 0.05$) – for all fatty acids separately.

(Slacanac et al., 2005)

The Biochemical Process of Fermentation

Fermentation refers to the metabolic process by which microbes produce energy in the absence of oxygen and other terminal electron acceptors in the electron transport chain. All organisms need energy to grow, and it is known that this energy comes from the reduction of adenosine triphosphate (ATP) to andenosine diphosphate (ADP), resulting in the release of energy and a phosphate group. Cells obtain ATP from the chemical breakdown of glucose to form two molecules of pyruvate, also known as glycolysis **(Figure 1).** Although this process requires ATP, it results in a release of four molecules for a net gain of two ATP molecules. Once pyruvate is formed, it can be processed aerobically (in the case of mammalian cells), or anaerobically (in the case of fermentation). Two of the most important fermentation processes that are used on an industrial scale are ethanol or lactic acid fermentation **(Figure 1).**

Figure 1. Glycolysis and fermentation



(Yim & Glover, 2008)

Yogurt

Yogurt is produced through the fermentation of milk by lactic acid bacteria, usually *lactobacillus bulgarius* and *Streptococcus thermophilus*. Milk is usually first heated, homogenized and is then cooled in order for the starter culture or bacteria to be added. The bacteria then use the lactose in milk as a food source for the fermentation process, generating lactic acid as a result. Lactic acid lowers the pH of the yogurt thereby acting as a preservative since most pathogenic bacteria cannot grow in acidic conditions, makes it tart, and causes the milk proteins to coagulate and set, forming yogurt.

Cheese

Cheese is fermented milk, which has a portion of its water and lactose removed. There are 4 basic steps to making cheese: curdling, draining, pressing and ripening. Curdling is when the liquids (whey) are separated from the solids (curds) by the addition of a fermenting agent. Cheese then undergoes draining, where the whey is eliminated from the curd. This step is important to attain the correct moisture content in the cheese. Pressing occurs next, in order to eliminate more whey. Finally, the cheese is ripened and takes on its unique characteristics of flavour, texture and aroma.

Kefir

Traditionally, the fermentation of kefir was done at home as a mechanism to preserve milk before the advent of refrigeration. Nowadays, the commercial production of kefir starts with the pasteurization of milk in order to kill bacteria that can cause unwanted spoilage of the end product, which is heat-treated in order to denature the whey proteins. The product is then cooled, and kefir grains or culture are added. The kefir culture is known as “grains” because it forms grain-like casein polysaccharide-microorganism particles during fermentation. Once the culture has been added, the mixture is incubated for 24 hours before they are removed and the product is pasteurized, chilled and packaged.

Technological Difficulties of Producing Fermented Goat Milk Products

In the European Union, goat milk products are considered to be the dairy product with the greatest marketing potential and, therefore, several characteristics of goat milk are currently the focus of increased research interest. However, alongside the nutritional and therapeutic advantages of goat milk and its fermented products in particular, there are also some technological difficulties associated with the production of fermented goat milk with good sensory properties. The majority of these issues are associated with the specific composition and structure of goat milk. As goat milk has a slightly lower casein content than cow's milk, with a very low, or sometimes even absent amount of αS1-casein, and a higher degree of casein micelle dispersion, the consistency of fermented goat milk products has been determined to be one of the critical problems. In addition, seasonal changes in the composition of goat milk also influence the consistency of fermented products. These factors influence the curd-forming properties in fermented goat milk, which is much weaker than that of cow milk. Furthermore, another problem is over-acidification of fermented goat milk products in comparison with those of cow milk (Slancanac et al., 2010).

Health Benefits of Fermentation

We have discussed the beneficial properties of goat milk, making this dairy product superior in terms of health benefits in comparison to cow's milk. The additional benefits of fermented dairy products are also known, therefore it may be said that fermented goat dairy products exert greater health advantages.

Hypotensive peptides

The fermentation of the proteins in milk by lactic-acid bacteria may result in the release of tripeptides with blood pressure lowering activities. Two of these peptides, isoleucylprolyl-proline (Ile-Pro-Pro) and Valyl-Prolyl-Proline (Val-Pro-Pro) have been isolated consistently from casein digests and have been shown to lower blood pressure in spontaneously hypertensive rats and in humans with mild hypertension. In another study, middle-aged subjects with moderate hypertension (systolic readings between 140 and 180 mm Hg and diastolic readings between 90 and 110 mm Hg) received 150 ml of a milk fermented with *L.helveticus* LBK-16H, twice daily for 16 weeks, with 7.5 mg/100g of Ile-Pro-Pro and 10mg/100g of Val-Pro-Pro. The control group received the same product as the experimental group but without the two active peptides. Blood pressure was monitored at the beginning and at the end of the trial with an automatic, 24-hour pressure recorder and, in addition every participant was subjected to nine blood pressure controls at regular predetermined intervals. The results showed that there was a difference of 0.9 mm Hg in the systolic pressure and a -1.8 mm Hg between the *L.helveticus* and the control groups, respectively. This kind of a reduction in blood pressure is considered epidemiologically significant in terms of public health.

Furthermore, *in vivo* and *in vitro* ACE-inhibitory activity originating from the fractionation of caseins has been detected in milk products using different bacterial strains during fermentation. ACE is one of the main blood pressure-regulating molecules as it is able to synthesize angiotensin II, a potent vasoconstrictor. Furthermore, this process of angiotensin II synthesis induces bradykinin degradation, which is a powerful vasodilator. Therefore, the overall effect of inhibiting ACE results in a lowering of blood pressure. A study on goat's milk kefir detected the presence of ACE-inhibitory peptides that showed anti-hypertensive activity, two of which were particularly potent. The digestion with gastric and pancreatic enzymes further hydrolyzed the original peptides and some of the resulting products also exhibited vasomotor effects (Brunser et al., 2007).

Antimicrobial activity

As we have mentioned in a previous article, many bioactive polypeptides have been identified in encrypted form in milk proteins, which are released during fermentation and/or during digestion of these proteins by the gastric and pancreatic enzymes in the gastrointestinal tract. These peptides include families or single peptides called caseicidins, isracidins, and lactoferrin, which have the ability to lyse pathogenic bacteria including *Streptococcus mutans, E.coli* O157:H7 and *Enterobacter zakazakii*. The later has been recognized as the etiological agent of a form of neonatal meningitis (Brunser et al., 2007).

Gastrointestinal and urogenital health

There have been numerous studies conducted in order to determine the effects of fermented goat milk on the inhibition of various intestinal and urogenital pathogens. For example, Slacanac et al (2004) investigated the effects of fermented milk on urogenital pathogen inhibition and found a considerably higher inhibitory effect of goat milk fermented with *B. longum* on the growth of *C. albicans* compared with that of fermented cow milk. Similarly, Pavlovic et al. (2006) analysed the antagonistic action of goat and cow milk fermented with *B. longum Bb-46* on the pathogenic organisms *Serratia marscenses* and *Campylobacter jejuni.* Their results also showed a greater inhibitory effect of fermented goat milk.

A Chilean study investigated the effects of a milk formula acidified by the addition of *L.helveticus* and *S. thermophiles* on 82 weaned infants less than 12 months of age for a 6-month period. In addition, a group of 104 infants, comparable in terms of the anthropometric and socio-economic points of view, and who received their medical care in a nearby area served as controls and received a non-fermented milk of similar composition. The fermented milk demonstrated a clear preventive effect against new episodes of diarrhea, as the incidence, duration and frequency of recurrence were significantly lower in this group. Similarly, various species and strain of lactic acid bacteria have been evaluated for their ability to modify the course of viral diarrhea, and *L.rhamnosus* GG (LGG) has been the most extensively tested, especially for its effects on diarrhea associated with rotavirus infection in children. When administered in association with fermented milk, a significant shortening of the evolution of the disease was observed in comparison to the control group (Brunser et al., 2007).

Antioxidative and anticarcinogenic effects

Kullisaar et al. (2003) studied the antioxidative effects of a fermented goat's milk. They assigned twenty-one healthy subjects to two treatment groups: goat's milk group and fermented goat's milk group (150g/d) for twenty-one days. Consumption of the fermented goat's milk improved anti-atherogenicity in healthy subjects, prolonged resistance of the lipoprotein fraction to oxidation, lowered levels of peroxidized lipoproteins, oxidized LDL, and glutathione ratio, and enhanced total antioxidative activity. Furthermore, the subjects receiving the fermented goat's milk group showed an altered prevalence and proportion of lactic acid bacteria species in the gut microflora.

Animal food products, particularly dairy products, are rich in conjugated linoleic acid (CLA). CLA is known to possess anti-carcinogenic, atherosclerosis inhibiting and body fat reducing properties, and hence its consumption is considered to have health benefiting effects. Indratiningsih et al. (2012) investigated the effect of fermentation on changes in the CLA content in goat milk. The results demonstrated that the fermentation process increased the CLA content of goat milk from 3.09 mg/g fat in fresh milk to 3.26 mg/g fat in fermented milk.

Allergy management

A number of studies have shown the relationship between allergic conditions and the composition of the gut microbiota. The levels of bifidobacteria in stools from allergic infants, particularly those with atopic eczema, are significantly lower than those in healthy subjects. Therefore, it has been proposed that the intake of fermented products containing lactic acid bacteria could be used to achieve homeostasis of the gut microbiota and thereby decrease the symptomatology in infants at risk for allergy (Brunser et al., 2007; Gilliland, 1999).

Conclusion

Fermented dairy products have a long history of being important dietary components for humans, and the more recent application of modern research methodologies is showing that the bacteria and the products of the fermentation process participate in a variety of functions that are positive for health and wellness of all age groups.

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