

## LACTOPEROXIDASE SYSTEM AS NATURAL APPROVED MILK PRESERVATIVES

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Received 2/08/2009.

Accepted 13/08/2009.

### SUMMARY

The lactoperoxidase system (LP-system) is an acceptable chemical method for raw milk preservation, especially in rural areas where refrigeration facilities are absent to farmers.

Milk production in most African countries is dominated by small-scale traditional production systems using low yielding local breeds. Therefore, processors who operate in such situations must rely on small volumes of milk from many farmers.

Application of the LP-system prolongs the shelf life of raw milk and also encourages grouping

of farmers hence facilitating milk collection by processors. The application of the LP-system is a recent preservation method for milk in many African countries whose efficiency has been proven. Therefore, need arose for further studies on the influence of this method on milk processing as well as the quality dairy products. The LP-system was activated by adding 10 ppm sodium thiocyanate and 8.5 ppm sodium percarbonate to fresh milk.

### INTRODUCTION

Milk represents one of the fastest returns for small-scale livestock keepers. It is a key element for household food security. The generation of surplus milk brings income to women and children who are usually in charge of the milk - producing animals such as goats, sheep and cows. Milk can frequently generate

the only regular income for rural families and is therefore essential for their survival. In remote areas where there is a huge demand for fresh, good quality milk, small-scale milk producers face a major problem in accessing distant markets. Most of the small farmers have no direct access to the market. Middlemen

therefore take the biggest share of the consumer milk price. Milk can usually be transported unrefrigerated for up to 20 km but after a certain period will begin to deteriorate. Souring sets in and the milk quickly becomes unsuitable for processing and/or unfit for human consumption.

Bacterial growth can be retarded by refrigeration, thereby slowing down the rate of deterioration. Under certain conditions refrigeration may not be feasible due to economical and/or technical reasons. Difficulties in applying refrigeration are specially a problem for certain areas in countries setting up or expanding their milk production. Some chemicals have been tried as milk preservatives in rural areas, but are now forbidden due to toxicological reasons. In these situations, it would be beneficial to have access to a method, other than refrigeration, for

### **THE SYSTEM**

The lactoperoxidase system is a natural antibiotic system in milk. One of its unique biological functions is an antibacterial effect in the presence of hydrogen peroxide and thiocyanate.

The lactoperoxidase/thiocyanate/hydrogen peroxide system is an indigenous antibacterial system in milk and human saliva and tears. The enzyme

retarding bacterial growth in raw milk during collection and transportation to the dairy processing plant.

Interest has recently been focused on the indigenous antibacterial systems in milk to determine if these could be applied practically to preserve raw milk. During the last decade, basic and applied research has demonstrated that one of these systems, the lactoperoxidase/thiocyanate/ hydrogen peroxide system (LP-system) can be used successfully for this purpose.

Following toxicological tests and consideration by the joint FAO/WHO Expert Committee on food additives, the method was finally approved by the Codex Alimentarius Commission in 1991 for field implementation.

lactoperoxidase is present in bovine and buffalo milk in relatively high concentrations. The enzyme has no antibacterial effect on its own, but it can oxidize thiocyanate ions in the presence of hydrogen peroxide. By this reaction, thiocyanate is converted into hypo-thiocyanous acid (HOSCN). At the pH of milk, HOSCN is dissociated and exists mainly in the form of



hypothiocyanate ions (OSCN<sup>-</sup>). This agent reacts specifically with free sulphhydryl groups, thereby inactivating several vital metabolic bacterial enzymes, consequently blocking their metabolism and ability to multiply. As milk proteins contain very few sulphhydryl groups and those that are present are relatively inaccessible to OSCN<sup>-</sup> (masked), the reaction of this compound is in milk quite specific and is directed against the bacteria present in the milk.

The lactoperoxidase system is a natural component of saliva and gastric juice in humans and consequently non-toxic when used according to the Guidelines of the Codex Alimentarius Commission (See Guidelines for the Preservation of Raw Milk by Use of the Lacto-peroxidase System (CAC/GL 13-1991)).

There are three components required for the activation of the LP-s; the enzyme lactoperoxidase which is abundant in raw milk; and thiocyanate and hydrogen peroxide which are present in milk in varying low concentrations.

Bovine milk contains about 30 mg/liter of LP enzyme and the concentration is fairly constant throughout the lactation. The amount necessary for the anti-bacterial (L-P) activity is just one mg per liter.

Thiocyanate is naturally present in fresh raw milk in varying concentrations “usually in 5 PPM naturally present”, depending on the feed given and on the species/breed of animal. Feeds such as cabbages of various types are rich in sulphur – containing components, which are the source of thiocyanate in milk.

The third component of the system, H<sub>2</sub>O<sub>2</sub> it is not normally detected in the milk and its source in vivo is not quite clear. But traces in newly drawn milk have been found and are possibly derived from the metabolism of the mammary tissue and leucocytes. Another source seems to be xanthine oxidase in the milk reacting with some substrate, e.g. hypoxanthine.

In freshly drawn milk the antibacterial activity of LP system is quite weak and lasts for up to two hours because the milk contains only suboptimal levels of the thiocyanate ion and hydrogen peroxide. Therefore, reactivation of L-P system is required as safe and effective system approved by the Codex Alimentarius Commission in 1991 for raw milk preservation for dairy sector.

## PRACTICAL APPLICATION OF THE METHOD

The lactoperoxidase system can be activated in raw milk to boost its antibacterial effect by an addition of thiocyanate (preferably in powder form) as sodium thiocyanate and hydrogen peroxide in the form of sodium percarbonate by the following procedure:

Adding 14 mg (10 ppm) of Sodium thiocyanate (NaSCN) per liter of milk {to increase the

overall level to 15 PPM (5 ppm naturally present). followed by is thoroughly mixing for 30 seconds to ensure an even distribution of the SCN and then adding 30 mg (8.5 ppm) of a granulated sodium per-carbonate and mixing again for 2 minutes [Guidelines for the Preservation of Raw Milk by Use of the Lactoperoxidase System (CAC/GL 13-1991)].

The enzymatic reaction is started in the milk within about 5 minutes from the addition hydrogen peroxide (sodium per-carbonate).

TECHNICAL SPECIFICATION OF SODIUM THIOCYANATE and SODIUM PERCARBONATE		
Definition	SODIUM THIOCYANATE	SODIUM PERCARBONATE
Chemical name	Sodium thiocyanate	Sodium percarbonate (*)
Chemical formula	NaSCN	2Na 2CO <sub>3</sub> ·3H <sub>2</sub> O <sub>2</sub>
Molecular weight	81.1	314.0
Assay content	98-99%	85%
Humidity	1-2%	.....
* Joint FAO/WHO Expert Committee on Food Additives.		

The activation of the lactoperoxidase system should be carried out within 2-3 hours from the time of milking.

The activation of the Lactoperoxidase system has proven to be both bactericidal and bacteriostatic effect to a wide variety of hours at ambient tropical temperatures (30° C).

This means that producers can then transport the milk from the collection point to a processing centre and thereby significantly

microorganisms which maintains the keeping quality and effectively extends the shelf-life of the raw milk under tropical conditions for 7- 8



increase the income generated at farm and producer group level.

The use of the lactoperoxidase system does not exclude the necessity of pasteurization of the milk before human consumption. Neither does it exclude the normal precautions and handling routines applied to ensure a high hygienic standard of the raw milk.

The lactoperoxidase system cannot improve the bacterial quality of milk but maintains the bacterial quality of milk to that of the application.

The Committee on Milk and Milk Products {Report of the fifth session of the codex committee on milk and milk products "Rome, Italy, 30 June -5 July 2003} noted that the Codex Guidelines were only meant to be

utilized when refrigeration of raw milk was not feasible or sufficient and that in any case, milk or milk products manufactured using the Lactoperoxidase System should be excluded from international trade.

Some experts highlighted that LP-s is a processing aid rather than a food additive and therefore, it would seem more appropriate to discuss this issue within the Codex Committee on Milk and Milk Products.

Therefore, need arose for further studies on the influence of this system on milk processing as well as the quality dairy products.

## REFERENCES

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## استخدام منظومة اللاكتوبيروكسيداز في حفظ الحليب الخام

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### الملخص العربي

منظومة lactoperoxidase الكيمائي وسيلة طبيعية مقبولة لحفظ الحليب الخام طبقاً لقرار لجنة خبراء الإضافات الغذائية لمنظمة الأغذية والزراعة ومنظمة الصحة العالمية - لجنة الدستور الغذائي (CAC/GL13-1991) وخاصة في المناطق الريفية حيث لا توجد مرافق التبريد.

تاج الحليب في معظم البلدان الأفريقية يكون غالباً على نطاق صغير باستخدام نظم إنتاج تقليدية من سلالات محلية منخفضة العائد ، لذلك وفي مثل هذه الحالات يجب أن يُعتمد على كميات صغيرة من الحليب من العديد من المزارعين.

تطبيق نظام lactoperoxidase يطيل من فترة عمر الحليب الخام ويشجع المزارعين على زيادة الإنتاج ، ومن ثم سهّل تجميع الحليب عن طريق المصنعين.

استخدام نظام lactoperoxidase في الآونة الأخيرة كوسيلة لحفظ الحليب في العديد من البلدان الأفريقية أثبت كفاءة لذلك نشأت الحاجة لإجراء المزيد من الدراسات حول تأثير هذه الطريقة على تجهيز الألبان وكذلك نوعية منتجات الألبان التي يمكن أن يستخدم فيها.

ن تفعيل منظومة lactoperoxidase يكون من خلال إضافة ١٠ جزء في المليون من ثيوسينيت الصوديوم Sodium thiocyanate (NaSCN) و ٨,٥ جزء في المليون من بيركربونات الصوديوم Sodium percarbonate (2Na<sub>2</sub>CO<sub>3</sub>·3H<sub>2</sub>O) إلى الحليب الطازج.