RESEARCHES CONCERNING THE BEHAVIOR FOR THE MAIN REDOX AGENTS FROM COW’S MILK IN ACIDITY CHANGE

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Abstract

The redox agents from cow’s milk are more important for milk processing and preserving. The study for the behaviour for main redox agents from cow’s milk in acidity change are important for establish the best conditions for keeping the tasting characteristics.

Keywords: cow’s milk, redox agents, behaviour, acidity change

Introduction

The fresh milk has acidity from 16 to 19°Thorner. The acidity can be increase follow transform the lactose to lactic acid. The increase of acidity for cow’s milk can produce different changes for the properties of milk and this milk cannot use in processing.

The study of the redox agent behaviour in the case of acidity change is very important in analyse for consumer milk’s risk.

Experimental

For measure the Eh – redox potential and pH, it was used a Multitester C535 with glass electrode and platinum ring tip SP60X. To increase the acidity of milk it used 0.1n lactic acid solution and for decrease the acidity 0.1n NaOH solution was used. The used milk has density of 1.029 g/cm³ and 3.5% fat.

To eliminate the analytical errors the pure analysis substances: glutathione, riboflavine, and ascorbic acids, L-cysteine, from Merck SA were used. For comparing the obtained results for the raw milk, the function Eh (V) / pH (units) was used
Results and Discussions

If in the raw milk we introduce substances for neutralise the milk acidity (in the case of false of acidity –with Natrium or Calcium Carbonate) can be observed the decrease for the Eh potential with 0.2V and the increase for the pH with 6 units (figure 1).

![Figure 1. Correlation between Eh (mV) and pH for raw milk](image)

The pH increase is caused by consume of H\(^+\) ions by added the neutralise substances and decrease for oxidative groups content from milk. Like this curve is the value’s curve for Eh potential of glutathione from cows milk as response for the increase the pH (figure 2).

The decrease for Eh is great like as raw milk but less than decrease for milk with L-cysteine Eh. This is follow different Eh = - 0.039V and \( r_{\text{H}} = 15.4 \) for glutathione and only Eh = -0.14V and \( r_{\text{H}} = 9.3 \) for cystine. The redox system for glutathione are determined by more enzymatic systems, the main role play in this case the glutathione peroxydase:

\[
\begin{align*}
2\text{GSH} + \text{H}_2\text{O}_2 & \rightarrow \text{G-S-S-G} \\
\text{NADP} & \rightarrow \text{NADPH}
\end{align*}
\]

The reverse reaction is catalysed by glutathione reductase (NADP-controlled); the glutathione are considered a reverse redox system in the cell metabolism and activator for thiolic enzymes.
The glutathione can oxidise the unsaturated fats, can activate the enzymes, can transform the reduced sulpho-proteins in bond proteins, oxidise metiligloxal to lactic acids.

**Fig. 2.** Correlation between Eh (mV) and pH for glutathione from milk

In presence of glutathione peroxidase (GSHP), glutathione can be oxidised at G-S-S-G (disulfide glutathione) and reduce the hydrogen peroxide to water (without radically mechanism). Cysteine is readily converted to the corresponding disulfide, cystine, under oxidative conditions. Reduction of cystine to cysteine is possible using thiol reagents (e.g. dithiothreitol) (figure 3).

At higher pH values and by processing of cow’s milk are possible losses of available lysine, cystine, serine, threonine and some other amino-acids. In the case of cystine, the eliminated thiol-cysteine can form a second dehydroalanine residue (figure 4).

**Fig. 3.** Oxidation of cysteine to cystine – redox mechanism (Belitz, 1999)
The correlation $E_h/pH$ for the cow’s milk with L-Caseyne is presented in figure 5.

Cysteine is more reduced $E_h$ potential than glutathione, and glutathione are strong reduced $E_h$ potential than dehydroascorbic acid (DAsc) and transform the dehydroascorbic acid to ascorbic acid (AAAsc). The oxidation of ascorbic acid to dehydroascorbic acid (figure 6) and its further degradation products depends on a number of parameters: oxygen partial pressure, pH—very important here, the presence of heavy metal ions, traces of heavy metal ions Fe$^{3+}$ and Cu$^{2+}$ results in high losses (Ciobanu, 2002).

A decreasing tendency (but in the positive range of $E_h$) is registered for the $E_h/pH$ curve of ascorbic acid from milk (figure 7).

The rate of C vitamin degradation in airless media, which is substantially lower than that of non-catalysed oxidation is maximal at $pH = 4$ and minimal at $pH = 2$. 

Fig. 4. Elimination of thiol-cysteine from cysteine –chemical mechanism (Belitz, 1999)

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Fig. 5. Correlation between $E_h$ (mV) and $pH$ for Cysteine from milk

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Riboflavin (7,8-dimethyl-10-ribityl-isoalloxazine) is the building block of flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD) and is implicated in the electronic transfer (dependence Eh – pH in figure 8). Riboflavin is coenzyme for more air media dehydrogenase (like as Xanthine oxidase) and can transfer the electrons to molecular oxygen, produced H$_2$O$_2$ and flavoquinone (figure 9).

Follow he methylene blue added in milk, the media begin the oxidation, the methylene blue is reduced with an point of timed
stability at pH = 8.2 (figure 10). The Eh decrease tendencies continue after pH = 8.2 and the methylene blue is reduced to blue colour.

**Fig. 9.** Flavin enzymes transfer the electrons to molecular –mechanism (Belitz, 1999)

**Fig. 10.** Correlation between Eh (mV) and pH for methylene blue added in milk

**Conclusions**

The behaviour for the main redox agent from cow’s milk in the acidity media change is most important. Following this behaviour, the milk can be processed in more directions. The redox processes from milk are very important for tasting, physical and chemical properties changes. The control for the redox processes from cow’s milk can be a good indicator for food processing technologies.

**References**
