Impact of storage conditions on hydrolytic rancidity degree of the dry dairy powders

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Abstract
In this study was assessed the storage stability of whole milk powder and infant formula in different storage conditions by following correlations between lipolytic micro-organisms and acid degree value.

Keywords: whole milk powder, infant formula, acid degree value, storage, rancidity

1. Introduction
Hydrolitic rancidity results from the hydrolitic degradation of milk lipids. The hydrolysis is catalysed by lipases and produces free fatty acids (FFAs), some of which have a low flavor threshold and can cause unpleasant flavors in milk and milk products. The lipases involved are two types: indigenous milk enzyme (s) and enzymes of microbial origin [2].

Both the Bureau of Dairy Industries (BDI) and solvent extraction methods have been used for routine analysis of free fatty acids in milk and milk products (International Dairy Federation, 1991). The total FFA level is frequently expressed either as ‘acid degree value’ (ADV: meq FFA 100 g⁻¹ fat) or as mmol FFA L⁻¹ sample [1].

Milk powder has a low water content a characteristic that distinguishes it from any other milk product It is generally accepted that microbial growth does not take place in milk powder because of its low water content [1]. The lipases can survive during the manufacture of dried milk [3] and cause lipolytic defects in a wide range of fat-containing foods in which milk powder is an ingredient [5].

The purpose of this study was to assess the impact of storage conditions on lipolytic rancidity degree by the following:

- monitoring of the acid degree value (lipolyses marker) during storage;
- evaluation of the effect of storage time and temperature on the acid degree value;
- identification and determination of lipolytic micro-organisms from infant formula and whole milk powder samples; and comparison with maximum admitted levels, where there exist;
- identification of the correlations between lipolytic micro-organisms and acid degree value.

2. Materials and Method
Whole milk powder and infant formula were purchased from the same plant. Whole milk powder type taken in the study contains 26% fat. Infant formula has the same amount of fat but being designed for children’s between 0 and 12 months, is supplemented with vitamins and minerals. The shelf life of the products stored at temperature of 15°C is 18 months.

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Samples were analyzed at processing date (0) and during 3, 6, 9, 12, 15 and 18 months of storage in different conditions of temperature: room temperature and 15°C (which is the maximum temperature admitted by the Romanian Standard).

\[ WMP_{(0)} \] was the symbol for the whole milk powder analyzed after processing and \[ WMP_{(3)} \]... \[ WMP_{(18)} \] for the whole milk powder stored at room temperature during 3...18 months; \[ WMP_{2(3)} \]... \[ WMP_{2(18)} \] for the whole milk powder stored at 15°C temperature during 3...18 months.

\[ IF_{(0)} \] was the symbol for the infant formula analyzed after processing and \[ IF_{(3)} \]... \[ IF_{(18)} \] for the infant formula stored at room temperature during 3...18 months; \[ IF_{2(3)} \]... \[ IF_{2(18)} \] for the infant formula stored at 15°C temperature during 3...18 months.

The fat was extracted from the samples and the acid degree value was determined by titration with sodium hydroxide 0.1N.

The lipolytic micro-organisms assessed were: \textit{Staphylococcus aureus}, \textit{Bacillus cereus} and yeasts and molds. Myp agar was used for isolation and counting of \textit{Bacillus cereus}, Chapman and Baird-Parker agar for \textit{Staphylococcus aureus}, and Sabouraud agar for yeasts and molds.

Statistical analysis of the data was performed with Two-way ANOVA and Correlation, using GraphPad Prism version 3.00 for Windows, GraphPad Software, San Diego California USA, www.graphpad.com.

3. Results and Discussion

The acid degree value, both in the case of the whole milk powder and infant formula, has registered higher values for the samples stored at room temperature; between assortments, the values of this marker were higher in the case of the infant formula.

The biggest values were in the case of whole milk powder after 6\textsuperscript{th} month of storage both for samples stored at room temperature (1.99 mEq NaOH/100 g fat±0.003) and for the samples stored at 15°C (2.00 mEq NaOH/100 g fat±0.002), in the 15\textsuperscript{th} month of storage for the infant formula stored at room temperature (3.99 mEq NaOH/100 g fat±0.359) and in the 12\textsuperscript{th} months of storage for the infant formula (3.53 mEq NaOH/100 g grăisme±0.053) stored at 15°C temperature.

\[ \text{Figure 1. Variation of acid degree value during storage}^1 \]

The effect of storage temperature and time on the acid degree value was statistical analysed with Two-way ANOVA test of Prism 3.0 software. The temperature had no significant effect (\( P>0.05 \)) on the acid degree value in the case of the whole milk powder and had a significant effect (\( P \leq 0.05 \)) in the case of the infant formula. Instead storage time had a significant effect (\( P \leq 0.05 \)) in the case of the whole milk powder and very significant effect (\( P \leq 0.01 \)) in the case of infant formula.

Regarding the microbiological quality, only one sample of whole milk powder exceeded maximum admitted limit for \textit{Bacillus cereus} (<10 cfu/g) the others samples being in normal limits.

\textit{Staphylococcus aureus} was identified in two samples of the whole milk powder and four samples of the infant formula, although the Regulation no. 975/1998 does not provides the determination of this type of micro-organism [6]. For this reason and considering that were reported intoxications with staphylocoecal enterotoxin A [4] derived from reconstituted milk from milk powder, we recommend its value to be limited by a standard in milk powder and infant formula.

Total yeast and mold count, which exceeded the maximum admitted level (<10 cfu/g) in the three of the infant formula samples, were predominant molds from \textit{Penicilium}. In the case of the whole milk powder total yeast and mold count is not limited by a standard value. Nevertheless these were identified in the whole milk powder samples. As such, we recommend for the total yeast and mold count to be regulated by a standard value in the whole milk powder.

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1 LP1 – whole milk powder stored at room temperature; LP2 – whole milk powder stored at 15°C temperature; FC1 – infant formula stored at room temperature; FC2 – infant formula stored at 15°C temperature;
The correlation of lipolytic micro-organisms with acid degree value was assessed by using the Correlation test from Prism 3.0. Only in the case of the whole milk powder stored at 15°C temperature was found a small correlation of acid degree value with the total yeast and mold count.

4. Conclusion

The storage time affected the quality of the whole milk powder and the infant formula.

By supplementation of the infant formula with vegetable oils, the risk of lipolytic rancidity increases especially if the product is stored at room temperature.

Correlation between some lipolytic micro-organisms and the acid degree value indicates the fact that lipolysis degree is influenced by their presence, but for each type of micro-organism the effect starts at a specific level of microbial load.

References

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