

OXIDATIVE CHANGES IN VARIOUS FATTY FRACTIONS
OF POWDERED MILK

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The reduction of water content in milk powder to a level that brings down to a minimum the Maillard protein-sugar reactions, does not counteract the oxidation of fat. The latter reaction is accompanied by a number of undesirable changes (the formation of peroxides and carbonyl compounds having a strong unpleasant odour, the oxidation of vitamins and poly-nonsaturated fatty acids).

More than 90% of fat contained in milk powder has the form of fat balls in lipoprotein envelopes¹. These envelopes, as well as lactose, which in milk powder occurs in the form of glass-like frozen coat, protect the fat from the effect of atmospheric oxygen². A part of the fat (about 8% of that contained in milk powder), however, has no envelopes at all (the so-called free fat) and therefore it can oxidize more easily³.

No detailed data about the rate of free fat oxidation as compared with protein envelopes, are available in the literature. The aim of our work was to examine the rate of oxidation of various fatty fractions obtained from milk powder produced by the spray system.

The individual fatty fractions were separated from the milk powder using the extraction method first reported by Greenbank and Pallansch⁴ and modified by the author. As a result, four fractions were obtained: free glycerides, enveloped glycerides, free lipids and enveloped lipids. The so-called lipid fractions are a mixture of glycerides and phospholipids (ethanol added during the separation of these fractions permits the phospholipids to be freed more easily from the lipoprotein complexes).

Four series of samples taken from batches of milk powder freshly produced in various factories were tested, above all. These samples were stored for 5 months at a temperature of 20 and 37°C, and peroxide in-

crements in the individual fatty fractions were recorded over the storage period.

It has been found that fatty fractions present in the milk powder as the so-called free fat oxidized at a faster rate immediately after the powder has been produced, and that after the storage period had ended, their content was higher than that in the corresponding fractions of the fat provided with protein envelopes or in other ingredients of the dry fatless milk substance.

Table 1 illustrates differences in the original peroxide content and the oxidation rate for the individual fatty fractions.

Table 1

Peroxide content in various fatty fractions separated from the powder milk stored at 20 °C

Storage period (weeks)	mg of active oxygen per a kg of fat			
	free glycerides	enveloped glycerides	free lipids	enveloped lipids
0	5.17	2.84	5.53	3.14
3—4	5.54	3.78	5.77	3.94
6—8	7.30	5.25	8.47	4.51
10—12	8.22	5.86	10.23	5.79
14—16	9.13	6.79	13.90	6.35
18—20	9.49	7.25	15.20	7.33

The table gives mean values for the four series of samples. The comparison, however, of the oxidativeness of a selected fraction (e. g. free lipids) separated from samples of various milk batches permits a conclusion that the higher the initial peroxide content, the greater the peroxide increments during storage. This observation, consistent with the autocatalytic nature of the oxidation reaction, speaks for the elimination in the production of milk powder of any raw material having a tendency towards the so-called spontaneous oxidation.

The long induction period characteristic of the oxidation process of the basic substance of fat contained in milk powder means that this substance is highly resistant to oxidation but, on the other hand, it may give the appearances of no deterioration in the quality during the storage period. Therefore we suggest to make a stability test for the fat separated from the milk powder as such a test is a more reliable criterion of the reduced shelf life of milk powder than the determination alone of the current peroxide content.

In general, the rate of peroxide content increase in the fat contained in milk powder was relatively low. The final peroxide content in milk powder stored for about 5 months at a temperature of 20 and 37°C was

not higher than 5-12 mg of active oxygen per 1 kg of fat (in terms of total fat content), a value which must be regarded as a relatively low oxidation degree that does not impair to a significant extent the nutritive value of the product.

LITERATURE

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Streszczenie

OKSYDATYWNE ZMIANY W RÓŻNYCH FRAKCJACH TŁUSZCZOWYCH PROSZKU MLECZNEGO

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Przebadano 4 serie próbek proszku mlecznego rozpyłowego pod względem zmian oksydacyjnych w różnych frakcjach tłuszczowych. Stwierdzono, że frakcje tłuszczowe reprezentujące w proszku mlecznym tzw. tłuszcz wolny (wolne lipidy, wolne glicerydy) wykazywały na początku i po 5 miesiącach składowania z reguły wyższą zawartość nadtlenków niż odpowiednie frakcje tłuszczu osłoniętego otoczkami białkowymi (osłonięte lipidy, osłonięte glicerydy). Proponuje się stosowanie testu stabilności na wydzielonym z proszku tłuszczu jako wskaźnika obniżenia trwałości podczas składowania.

Résumé

MODIFICATIONS CAUSÉES PAR L'OXYDATION DES DIVERSES FRACTIONS LIPIDIQUES DES LAITS EN POUVRE

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Dans quelques lots de lait entier en poudre, fraîchement obtenus par pulvérisation, les modifications dues à l'auto-oxydation (peroxyde), furent étudiées pendant une période de 20 semaines de séjour en magasin, à 20 ou 37°C, emballés dans des

sachets scellés en polyéthylène. Dans ce but, les glycérides „libres” (ou non protégés), les glycérides „masqués” (ou protégés), ainsi que lipides totaux „libres” et les lipides totaux „abrités” furent extraits des échantillons analysés en employant le tetrachlorure de carbone, l'éthanol, et l'eau avec un mélange normalisé des échantillons.

On trouva que dans les fractions „libres” des glycérides, aussi bien que des lipides totaux, les quantités de peroxydes étaient nettement plus élevées que dans les fractions „masquées” correspondantes des poudres fraîchement préparées, et que, de plus, le taux d'accroissement des teneurs en peroxydes au cours de l'entreposage était beaucoup plus élevé dans les fractions „libres” des lipides totaux que dans les autres fractions lipidiques. Considérant la teneur relativement faible en phospholipides, comparée avec celle des glycérides, dans la matière grasse du lait, les résultats obtenus souligneraient le fait que les processus d'auto-oxydation se produisent dans les phospholipides „non protégés” avec une intensité nettement plus forte que dans les composants lipidiques restants, en grande partie „masqués”, des poudres de laits obtenues par pulvérisation.

Summary

OXIDATIVE CHANGES IN VARIOUS FATTY FRACTIONS OF POWDERED MILK

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In several batches of freshly manufactured spray full milk powders, autoxidative changes (peroxides) were investigated over a period of 20 weeks' storage (at either 20 or 37°C) in powders sealed in polyethylene bags. For this purpose „free” (or unprotected) glycerides, „screened” (or protected) glycerides, as well as „free” total lipids and „screened” total lipids were extracted from the analysed samples, using carbon tetrachloride, ethanol and water, in appropriate mixtures as selective solvents combined with a standard mixing of samples.

It was found that both in the „free” glyceride and total lipid fractions the amount of peroxides was distinctly higher than in the respective „screened” fractions of freshly manufactured powders, and, further, that, in the course of storage peroxide increase was much higher in the „free” total lipid fractions than in other fatty fractions. Considering the relatively low phospholipid content as compared with the glyceride fraction of milk fat, the obtained results emphasize that the autoxidative processes take place in the unprotected phospholipids to a much higher degree than in the remaining, mostly „screened” fatty constituents of spray milk powders.

Z u s a m m e n f a s s u n g

OXYDATIVE VERÄNDERUNGEN IN VERSCHIEDENEN FETTFRAKTIONEN DES MILCHPULVERS

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Vier Serien von Proben des sprühgetrockneten Milchpulvers sind untersucht worden um die oxydativen Veränderungen in verschiedenen Fettfraktionen zu ermitteln. Es wurde festgestellt, dass die im Milchpulver freie Fette (freie Glyzeride) repräsentierenden Fettfraktionen, wiesen ursprünglich und nach 5 Monaten Lagerung einen in der Regel höheren Peroxydgehalt, als die entsprechenden in Eiweiss-hüllen eingeschlossenen Fettfraktionen (umhüllte Lipide und Glyzeride). Es wird vorgeschlagen, einen Stabilitätstest des aus dem Pulver abgesonderten Fettes, als Index der Senkung der Pulverhaltbarkeit während der Lagerung, zu verwenden.

Р е з ю м е

ОКСИДАТИВНЫЕ ИЗМЕНЕНИЯ В РАЗНЫХ ЖИРОВЫХ ФРАКЦИЯХ МОЛОЧНОГО ПОРОШКА

С. ЗМАРЛИЦКИ (ВАРШАВА)

Испытывались четыре серии образцов молочного порошка, полученного сушкой распылением. Исследовались оксидативные изменения в разных жировых фракциях.

Установлено, что жировые фракции, составляющие в молочном порошке так называемые свободные жиры (свободные липиды, свободные глицериды), отличались как в начале, так и после истечения 5-месячного срока хранения, высшим содержанием перекисей, чем соответствующие фракции жиров, защищенных белковыми оболочками (защищенные липиды, защищенные глицериды).

Предлагается испытывать стабильность выделенных из молочного порошка жиров, в качестве показателя понижения устойчивости молочного порошка в процессе хранения.