Continuous Vacuum Foam-Drying of Whole Milk.
VI. Iron Enrichment

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Abstract

With the growing interest in iron fortification of foods, particularly milk, we studied the processing and keeping qualities of vacuum foam-dried whole milk after the addition of 10.6 mg per liter of iron in the form of ferric ammonium citrate. Added iron had no adverse effects on the dehydration process, initial flavor and dispersibility, or flavor and dispersibility after extended storage.

Introduction

Investigators agree that the American diet is nutritionally deficient in iron (3, 8, 16). Foods in the diets of infants, adolescents, and women do not provide enough iron to prevent iron deficiency anemia. The amount of iron that a person should ingest has not been established definitely (9); however, the problem has not been ignored. Amounts of iron fortification for proper nutrition have been suggested (7).

Iron enrichment of milk is one approach to decreasing the hazard of iron deficiency anemia, since milk is an important commodity in the American diet (10, 11). Many states now permit iron fortification with proper labeling and/or specified limits (6). Unfortunately, iron catalyzes the development of oxidative-type off-flavors in milk. To determine the extent of off-flavor development in fluid milk, investigators have studied effects of added iron from both ferrous and ferric forms (4, 5, 12). Their conclusions indicate either form is acceptable, but modifications in pasteurization should be made to inhibit the oxidative catalyzing effect of added iron.

This report summarizes effects of added iron on processing and storage behavior of whole milk dried by the vacuum foam process developed in our laboratory (13).

Procedure

1. Preparation of dry milk. A supply of raw clarified whole milk, representative of a large pool supply, was purchased from a local dairy. The milk was divided into two lots with one lot having the equivalent of 10.6 mg of iron per liter from ferric ammonium citrate, and the other representative of a typical feed for the process. Ferric ammonium citrate has little effect on flavor and nutritive value of milk and very favorable biological adsorption as compared to other supplemental sources of iron (14, 15). The two lots of milk then were processed successively in the same day in accordance with the method established for vacuum foam-dried whole milk (13). One exception was in the pasteurization step to accommodate recommendations when iron is added, i.e., pasteurize at 81 C instead of 78 C (5). Products of the process were packed in cans under nitrogen in the usual manner and stored at 3.3 C.

2. Taste panel evaluation. Samples were withdrawn from storage at intervals up to 40 wk and judged by triangle tests and by absolute scoring by a trained panel of judges. The objective of the triangle taste tests was to reveal differences in flavor due to iron only. Some samples were evaluated further in an absolute scoring method (2). Absolute scoring evaluations of typical products of the process

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have been reported (1).

Results and Discussion

Added iron made no significant difference in operating the vacuum foam-drying process. Triangle tests on the samples were made at 0, 1, 2, 3, and 4 wk and 2 and 4 mo. There was no difference between samples with and without added iron, and flavor defects attributable to oxidative reactions could not be detected.

Samples stored at 3.3 C were analyzed for flavor-keeping quality by the absolute scoring test from 2 mo to 10 mo storage. Scores indicate no difference in flavor due to added iron (Table 1).

Absolute scores have been superimposed on the curve of a previously published storage study of vacuum-foam dried whole milk in Fig. 1. We conclude that addition of iron at 10.6 mg per liter has no influence on the vacuum foam-drying of fresh whole milk. Addition of iron at 10.6 mg per liter has no effect on the keeping quality of dried whole milk.

References


Table 1. Effect of added ferric ammonium citrate on the flavor stability of vacuum foam-dried whole milk.

<table>
<thead>
<tr>
<th>Time</th>
<th>w Fe</th>
<th>w/o Fe</th>
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<tbody>
<tr>
<td>0</td>
<td>38.59</td>
<td>38.78</td>
</tr>
<tr>
<td>2 mo</td>
<td>38.50</td>
<td>38.38</td>
</tr>
<tr>
<td>3 mo</td>
<td>38.61</td>
<td>38.22</td>
</tr>
<tr>
<td>4 mo</td>
<td>37.45</td>
<td>37.90</td>
</tr>
<tr>
<td>6 mo</td>
<td>38.06</td>
<td>38.28</td>
</tr>
<tr>
<td>8 mo</td>
<td>38.63</td>
<td>38.00</td>
</tr>
<tr>
<td>10 mo</td>
<td>38.33</td>
<td>38.93</td>
</tr>
</tbody>
</table>

* All scores not significantly different at p=.05.

Fig. 1. Storage data of iron-enriched whole milk compared with previously published data on whole milk (1).