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Quality attributes of dried milk products packaged for long-term storage

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Quality attributes of dried milk products packaged for long-term storage

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ABSTRACT

There is a market for dehydrated foods, such as nonfat dry milk (NFDM), that are packaged for long-term storage for use in natural disasters or other emergencies. The objective of this research was to determine the sensory and nutritional quality of dried milk products packaged in No. 10 cans for long-term storage.

Wide variation was found between brands among headspace oxygen (0.03%-20.8%), can seam quality (poor-excellent), sensory quality (hedonic scores of 4.20-6.03 for overall acceptability), and vitamin A fortification (absent in 6 of 10 brands, although all labels indicated it was present).

Manufacturers and distributors of dried milk products packaged in cans for long-term storage need to observe good manufacturing practices to optimize sensory and nutritional quality, giving careful attention to can seam quality, product labeling, and vitamin fortification levels.

INTRODUCTION

Many studies have evaluated the quality of NFDM stored for up to one year (Ford, 1983; Hurrell, 1983; deBoer, 1984; Okamoto, 1985; Parris, 1989). The industry standard for shelf-life of NFDM milk is 18-24 months, but some studies have shown that NFDM can last much longer under proper conditions (Henry, 1947; Driscoll, 1985).

Various manufacturers of dried milk products have packaged product in No. 10 cans in a reduced oxygen environment to lengthen shelf-life. The objective of this research was to determine the variation in quality between 10 brands of dried milk products packaged for long-term storage.

METHODOLOGY

Samples
Ten brands of dried milk products (5 instant NFDM, 3 regular NFDM, and 2 whey beverages) packaged in No. 10 cans were obtained from retail distributors representing 7 manufacturers in 4 states. Product codes indicated the samples were less than 1 year old, except brand J (2 years), and brands A and C (unknown). Duplicate samples of each brand were evaluated.

Headspace Oxygen and Water Activity
Headspace oxygen was measured using the 3500-Series Headspace Oxygen Analyzer (Illinois Instruments, Inc., Johnsburg, IL). Water activity was measured using an Aqualab CX-2 (Decagon Devices, Inc., Pullman, WA).

Can Seam Evaluation
Can seams were evaluated by an using the SeamMate System (Onevision Corporation, Westerville, OH) to measure the following seam dimensions: thickness, width, body hook, cover hook, and overlap. Seam tightness was rated on a scale of 0-100%. The seams were given an overall rating of excellent, good, fair, and poor by an experienced evaluator.

Sensory Analysis
Sensory analysis was conducted at the BYU Sensory Laboratory using standard procedures. Samples were reconstituted to 9% solids and served in a randomized manner to a 50-member consumer panel in 4 visits. Panelists evaluated aroma, flavor, and overall acceptability using a 9-point hedonic scale.

Vitamin Determination
Vitamin analyses were conducted using an Agilent Model 1100 high performance liquid chromatograph (Agilent Technologies, Palo Alto, CA) equipped with a C18 reverse phase column (Phenomenex, Inc., Torrence, CA) and a fluorescent detector for Vitamins B1 and B2 (Arella, 1995), and using a diode array detector for vitamin A palmitate (Gomis, 2000). Determinations were carried out under subdued light.

Data Analysis
Data was analyzed for significance using Statistical Analysis System software (SAS Institute, 1999). A mixed model analysis of variance (PROC MIXED) with Fisher's LSD was used for the sensory data. PROC GLM with Duncan's Multiple Range Test was used for the water activity and vitamin data. Significant differences were defined as p<0.05.

RESULTS

Headspace Oxygen, Seams, and Water Activity

Headspace oxygen (Fig. 1) varied widely from brand to brand as influenced by oxygen removal method and can seam quality (Fig 2). Cans with higher than expected oxygen levels also had poor seams. Oxygen absorbers reduced the headspace oxygen better than a nitrogen flush, as long as the seams were hermetic.

The water activity varied from 0.14-0.28 (Fig.3), but all values were in a typical range, corresponding to 3%-5% moisture (Walstra, 1999).

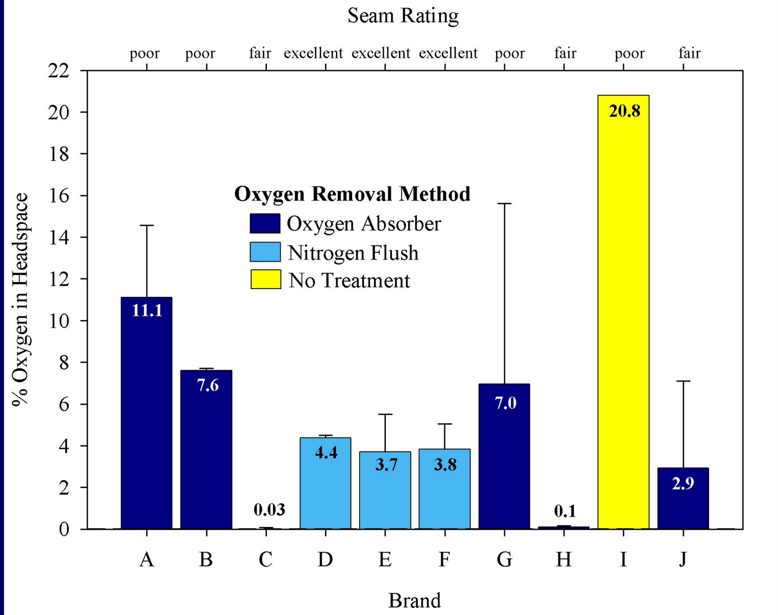


Fig. 1. Headspace oxygen in various brands of dried milk products. A-E are instant nonfat dry milk, F-H are regular nonfat dry milk, and I-J are dried whey milk substitutes. Bars represent standard deviation.

Brand	A	B	C	D	E
Seam cross section					
Tightness rating	35%	100%	55%	95%	70%
Overall seam rating	Poor	Poor	Fair	Excellent	Excellent
Brand	**F**	**G**	**H**	**I**	**J**
Seam cross section					
Tightness rating	85%	100%	95%	100%	60%
Overall seam rating	Excellent	Poor	Fair	Poor	Fair

Fig. 2. Representative can seam cross section, tightness rating, and overall seam rating for each brand.

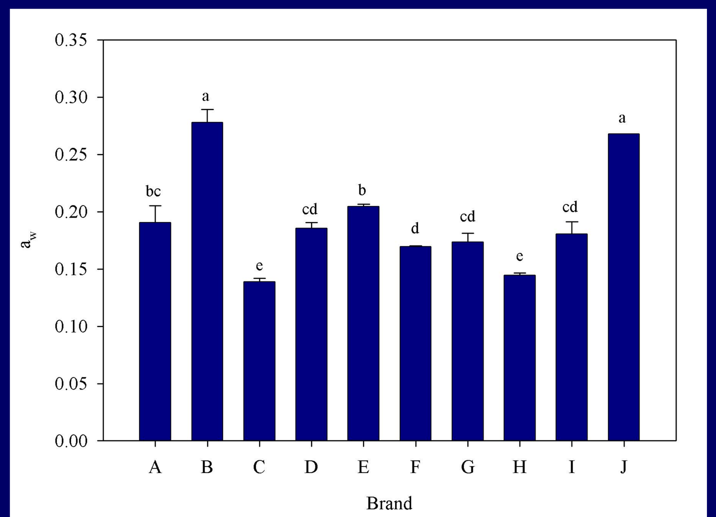


Fig. 3. Water activity in various brands of dried milk products. See Fig. 1. for brand definitions. Bars represent standard deviation. Like superscripts are not significantly different (p>0.05).

Sensory Results

There were significant differences in aroma, flavor and overall acceptability between the samples (Fig. 4). The brand that scored highest in overall acceptability had a poor can seam, suggesting that quality would not last over an extended storage time.

Regular NFDM samples had a mean flavor score significantly higher than the instant NFDM, but there were no significant differences in overall acceptability (Fig. 5). The whey beverages scored significantly lower than the other samples in flavor and overall acceptability.

Aroma		Flavor		Overall Acceptability	
Brand	Means	Brand	Means	Brand	Means
G	5.5185	G	6.0185	G	6.0324
A	5.4722	A	5.6065	C	5.6019
C	5.3935	B	5.5417	A	5.5509
I	5.2593	F	5.1296	F	5.0833
F	5.2593	I	4.7731	I	4.7870
J	5.2361	B	4.4583	E	4.5972
E	5.2222	E	4.4583	B	4.5556
B	5.1435	J	4.3657	J	4.4306
H	5.0509	D	4.1852	D	4.2546
D	5.0185	H	4.1296	H	4.2037

Fig. 4. Mean hedonic scores for aroma, flavor and overall acceptability. Vertical bars connecting brands indicate there is no significant difference between them (p>0.05).

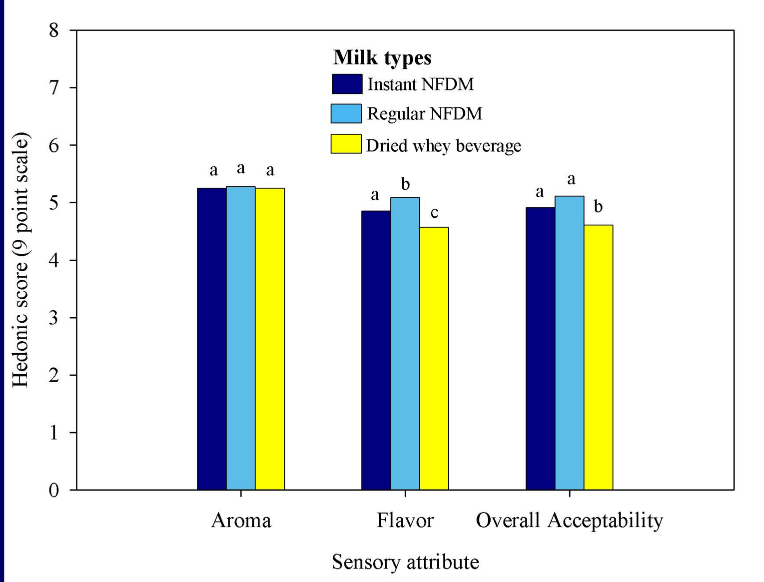
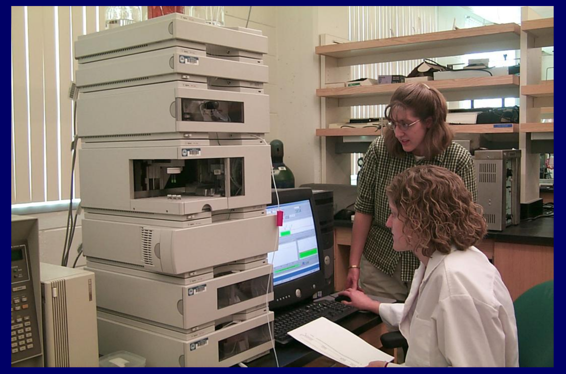


Fig. 5. Comparison of sensory attributes in regular NFDM, instant NFDM, and dried whey beverages. Like superscripts within attributes are not significantly different (p>0.05).



Vitamin Content

Thiamin content (Fig. 6) was not significantly different between brands, with the exception of one of the whey beverages, which was extremely high at 17.0 μg/g. The other samples were closer to the USDA Nutrient Database value of 4.13 μg/g.

Riboflavin content (Fig. 7) varied between the brands, from 7.0-15.5 μg/g, which is somewhat lower than the the USDA Nutrient Database value of 17.43 μg/g.

All of the products claimed to have been fortified with vitamin A, yet it was detected in only 4 of the brands (Fig. 8). Those brands containing vitamin A were near or at the target fortification level of 2000-3000 IU/Quart.

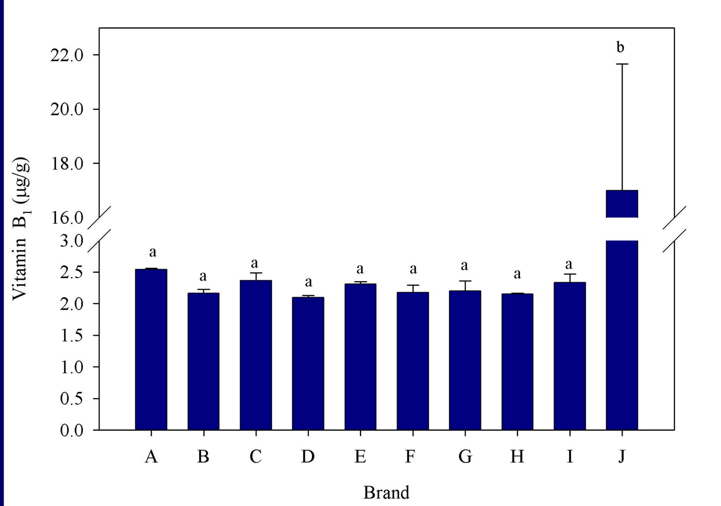


Fig. 6. Vitamin B_1 (thiamin) content in various brands of dried milk products. See Fig. 1. for brand descriptions. Bars represent standard deviation. Like superscripts are not significantly different (p>0.05).

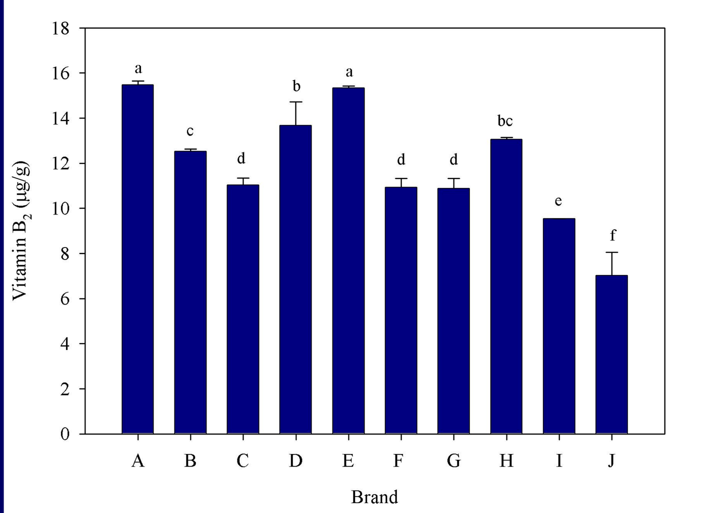


Fig. 7. Vitamin B_2 (riboflavin) content in various brands of dried milk products. See Fig. 1. for brand descriptions. Bars represent standard deviation. Like superscripts are not significantly different (p>0.05).

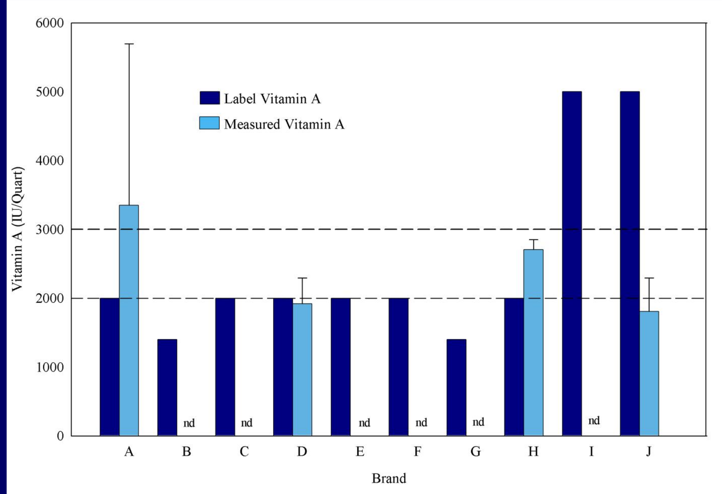


Fig. 8. Comparison of label and measured values of Vitamin A (retinol palmitate) in dried milk products. Amount given in IU per quart reconstituted according to label directions. See Fig. 1. for product descriptions. Bars represent standard deviation. nd = none detected. Dashed lines represent acceptable fortification range for milk set by U.S. regulations.

CONCLUSIONS

There is wide variation in sensory and nutritional quality of dried milk products available at the retail level packaged in cans for long-term storage.

Good manufacturing practices must be observed to optimize product quality, giving careful attention to can seam quality, product labeling, and vitamin fortification levels.

Consumers would be well advised to evaluate several brands of dried milk products prior to large quantity purchases.

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