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Quality of white rice retail packaged in No. 10 cans for long-term storage

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Quality of white rice retail packaged in No. 10 cans for long-term storage

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ABSTRACT

Various dry foods are available for retail sale in No. 10 cans, packaged for long-term storage in case of natural disasters or other emergencies. Little information is available regarding the quality of such products packaged for prolonged storage using hermetically sealed containers and a reduced oxygen atmosphere. The objective of this research was to evaluate and compare the quality of several different brands of white rice products packaged for long-term storage, available at the retail level.

Ten brands of rice products (7 long-grain white rice, 2 parboiled white rice, 1 instant white rice) packaged in No.10 cans were obtained from eight different retail distributors in four states. Observations included can headspace oxygen, can seam quality, Hunter color values, and water activity. A 50-member consumer panel evaluated aroma, flavor, texture, and overall acceptability using a 9-point hedonic scale. Thiamin content was compared to label claims.

Headspace oxygen was <2% in all except one can that was missing the oxygen absorber and in one brand that had oxygen absorbers that appeared to be expended. Significant variation in can seam quality was observed, with one-fourth of the cans failing to meet specifications for a hermetic seal. Water activity ranged from 0.27 to 0.61. Hunter L* values ranged from 61 to 78. There were significant differences between brands in sensory scores; however, all brands received overall acceptability scores above 6 (like slightly). Thiamin content ranged from 0.32 to 4.47 µg/g, which was lower than amounts claimed on package labels.

Variation in the quality of packaging of white rice products available at the retail level suggests that manufacturers need to ensure proper packaging to retain product quality during long-term storage. Buyers should be aware of potential differences between brands regarding the adequacy of packaging.

INTRODUCTION

During storage, milled rice undergoes continuous physical and chemical changes. Many enzymes are active (Charastil 1990). Proteins oxidize causing changes both in texture and aroma (Juliano 1985; Moritaka and Yasumatsu 1972). Lipids in the rice endosperm, at a concentration of 0.8%, undergo hydrolysis and oxidation which lead to undesirable changes in aroma and taste (Davies and others 1980). Hexanal, which originates from autoxidative decomposition of linoleic acid, is considered the major stale constituent of cooked rice (Tsugita and others 1983). Yellowing of rice during storage is due to Maillard browning reactions of protein with reducing sugars which are concentrated in the surface layer of milled rice (Pelshenke and Hampel 1967; Barber 1972). In addition, insects, mold, and other organisms can induce changes in the constituents of rice. Extensive research has shown the most important environmental factors influencing these changes are moisture, temperature, and oxygen (Pillaiyar 1979). Most of the research on the storage of milled rice has been limited to relatively short-term studies, usually under two years.

The objective of this research was to evaluate and compare the quality of several different brands of white rice products commercially packaged for long-term storage, available at the retail level.

METHODOLOGY

Samples

Ten brands of white rice (7 regular milled, 2 parboiled, and 1 instant) packaged in No. 10 cans were obtained from retail distributors in four states. Product codes indicated the samples were less than 1 year old, except brands C and E (3 years old) and brands A and D (no code). Duplicate samples of each brand were evaluated.

Headspace Oxygen, Can Seam, and Water Activity

Headspace oxygen was measured using the 3500-Series Headspace Oxygen Analyzer (Illinois Instruments, Inc., Johnsburg, IL). Can seams were evaluated 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 good, satisfactory, or poor by an experienced evaluator. Water activity was measured using an Aqualab CX-2 (Decagon Devices, Inc., Pullman, WA).

Color

Hunter L*, a*, and b* color values of the uncooked rice were measured using a Hunter ColorFlex Spectrophotometer (Hunter Associates Laboratory, Inc., Reston, VA).

Sensory Evaluation

Sensory analysis was conducted at the BYU Sensory Laboratory using standard procedures. Samples were cooked and kept in heating plates, then served in a randomized order to a 50-member consumer panel in 4 visits. Panelists evaluated aroma, flavor, texture, and overall acceptability using a 9-point hedonic scale.

Thiamin

Thiamin (Vitamin B_1) analysis followed the procedure of Arella (1995). Analyses were made 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 fluorescence detector. Determinations were carried out under subdued light. Reported values were adjusted to account for a 78% recovery rate.

Data Analysis

Data was analyzed for significance using Statistical Analysis System software (SAS Institute, 1999). A mixed model analysis of variance (PROC MIXES) with Duncan's Multiple Range test was used for the sensory data. Significant differences were defined as $p<0.05$.

RESULTS AND DISCUSSION

Headspace Oxygen, Can Seam, and Water Activity

Headspace oxygen varied between brands, ranging from <0.01% to 19.9% (Fig. 1). All but one can of one brand (Brand F) had an oxygen absorber; the difference between these two cans of the same brand was large (1.21% vs. 19.8%). The oxygen absorbers in both cans of Brand A appeared to be expended. Can seams were satisfactory except for two brands which had cans with no overlap (Fig. 2). Water activity varied significantly between brands (Fig. 3). The instant rice had an average water activity of 0.27. This was lower than the regular and parboiled rice, which ranged from 0.35 to 0.61. The ideal moisture content for rice stored for more than six months is 12% (Juliano 1985), which corresponds to a water activity of approximately 0.42 (Iglesias and Chirife 1982).

Color

There were visible color differences between brands when the cans were first opened. The L* values ranged from 61.6 to 77.9, the a* values ranged from -0.99 to 2.74, and the b* values ranged from 15.4 to 26.8 (Table 1). The parboiled samples had the smallest L* values and the largest a* and b* values. The instant brand had a lower a* value, a slightly higher L* value, and a similar b* value compared to the regular milled rice.

Sensory Evaluation

All hedonic scores for each of the attributes tested were close to 6, 'like slightly'. The hedonic scores for aroma ranged from 5.88 to 6.59, with no observable pattern. The scores for flavor ranged from 6.05 to 6.70. The instant rice received the highest average score for flavor, which was significantly different ($p<0.05$) from most of the other samples. The overall acceptability scores ranged from 6.06 to 6.79. Brand C, one of the 3 year old samples, received the highest overall acceptability score; it also had extremely low oxygen in the headspace and can seams rated as 'good.'

Thiamin

Fig. 5 shows the thiamin content of the rice samples, compared to label declarations and the USDA National Nutrient Database for Standard Reference (USDA, 2003), which is 0.7 µg/g for un-enriched regular milled rice, 1.0 µg/g for un-enriched parboiled rice, 5.76 µg/g for enriched regular milled rice, and 5.96 µg/g for enriched parboiled rice. There is no USDA value for un-enriched instant rice. Only three brands (Brands D, E, and G) had the thiamin content declared on their label, and in each of those brands the amount present fell below label values.

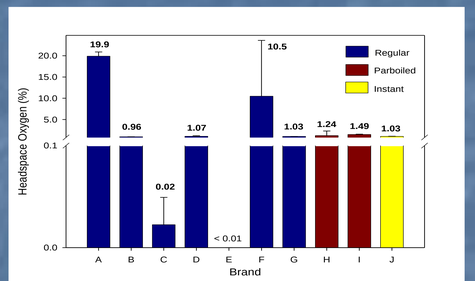

Fig. 1. Headspace oxygen in canned milled rice. Error bars represent standard deviations.

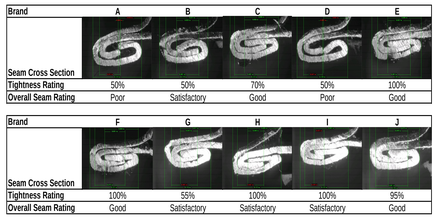

Fig. 2. Can seam cross section. Photos are representative of the seams from both cans evaluated of each brand.

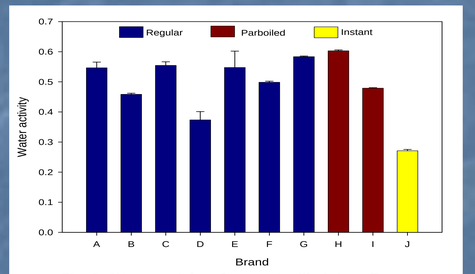

Fig. 3. Water activity of canned milled rice. Error bars represent standard deviations.

Table 1. Hunter L*, a*, and b* values for color in various brands of canned milled rice.

Brand	Type	L* value		a* value		b* value	
A	regular	73.2	0.25[a]	0.61	0.07	17.4	0.02
B	regular	73.8	0.18	0.30	0.02	15.8	0.05
C	regular	73.8	0.60	0.84	0.03	17.9	0.07
D	regular	73.0	0.17	0.38	0.22	17.6	0.48
E	regular	72.4	2.63	0.90	0.06	17.4	0.40
F	regular	73.7	0.81	0.12	0.02	15.5	0.03
G	regular	72.8	0.18	0.55	0.09	16.5	0.29
H	parboiled	61.6	0.82	2.60	0.06	26.5	0.33
I	parboiled	63.2	0.16	2.57	0.24	25.1	0.52
J	instant	77.9	0.82	-0.97	0.03	15.8	0.01

[a] Means of two cans standard deviations

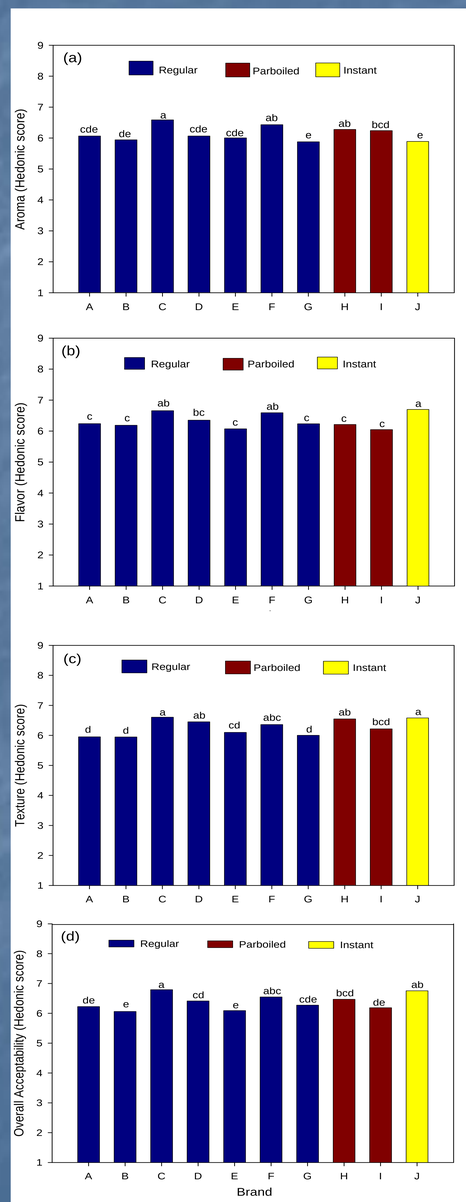

Fig. 4. Hedonic scores of canned milled rice: (a) aroma, (b) flavor, (c) texture, and (d) overall acceptability. Like superscripts indicate no significant difference ($p > 0.05$).

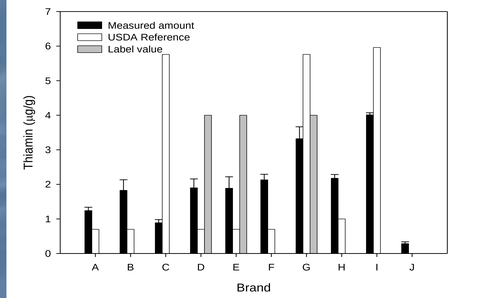

Fig. 5. Thiamin content of canned milled rice. Brands C, G, and I were labeled as being enriched with thiamin. Error bars represent standard deviations.

CONCLUSIONS

Variation in the quality of packaging of white rice products available at the retail level suggests that manufacturers need to ensure proper packaging and labeling to retain product quality during long-term storage. Buyers should be aware of potential differences between brands regarding the adequacy of packaging and the accuracy of label declarations.

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