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A Research Note
COLOR STABILITY OF MAPLE SIRUP IN VARIOUS RETAIL CONTAINERS

INTRODUCTION

DURING recent years, the quality and availability of the traditional metal container used for retail sale of pure maple sirup has declined, encouraging the use of plastic containers for this purpose. Two types are currently in commercial use. Reports from the maple industry suggest that maple sirup darkens while stored in these containers. Responding to the need for more definite information on color stability of maple sirup stored in containers of different materials, this paper reports the results of a study of color stability of maple sirup in four types of containers stored at three temperatures.

EXPERIMENTAL

Maple sirup

Four samples of maple sirup were obtained from commercial processing plants. They represented a range of color from AA to B grade on the USDA grading scale.

Containers

Containers made of four materials were tested. The quart size of each was used since it is the retail volume of sirup most generally stored. These were (1) glass in the form of a round, small-mouthed, screw-capped bottle; (2) tin-plated steel represented by the standard maple sirup can; (3) a commercial container made of XT Polymer; and (4) a commercial polyethylene maple sirup jug. The tinned containers were carefully selected for top quality, i.e., freedom from rust, solder flux and the absence of thin spots on the tinning.

Each batch of maple sirup was heated to 85°C and immediately transferred to containers of each material. The containers were filled to leave a small, uniform headspace, typical of commercial canning. They were quickly capped and placed horizontally so that the hot sirup would sterilize the underside of the cap and the container's headspace. After cooling, a container of each material with each of four sirups was stored at 4°C in a refrigerator, at 22–23°C in a cabinet, and 32°C in a heat-controlled oven.

After 6 months, the containers were removed from storage, shaken to mix their contents, and allowed to stand 24 hr at room temperature. Since the containers were filled hot and not opened during the storage period, no microbiological tests were made. The sirup samples were then evaluated for color and flavor. Color being the sirup characteristic of immediate interest, it was measured not only according

[1] Retired

Table 1—Color of maple sirup stored in darkness in various containers for 6 months at various temperatures

	Sirup 1		Sirup 2		Sirup 3		Sirup 4	
	Mac-Adam	USDA	Mac-Adam	USDA	Mac-Adam	USDA	Mac-Adam	USDA
Original	100	AA	125	A	140	B	155	B
Container and temp.								
Glass								
4°C	120	A	130	A	150	B	160	B
23°C	115	A	145	B	145	B	155	B
32°C	120	A	120	A	140	B	155	B
Tin								
4°C	115	A	130	A	150	B	165	B
23°C	110	AA	130	A	130	A	160	B
32°C	110	AA	110	AA	125	A	160	B
XT Polymer								
4°C	125	A	135	A	160	B	170	Un
23°C	140	A	155	B	155	B	170	Un
32°C	145[a]		145	B	165	B	180	Un
Polyethylene								
4°C	130	A	145	B	165	B	175	Un
23°C	135	A	165	B	165	B	165	B
32°C	145	B	165	B	185	Un	195	Un

[a] Sample lost. Estimated value supplied to permit data analysis.

Table 2—Color increase of maple sirup in four containers at three temperatures

Analysis of Variance				
Variance	Sum of Squares	Degrees of Freedom	Mean Square	F
Temperature (T)	51.0	2	25.5	0.49
Sirup	1435.4	3	478.5	9.34**
Container (C)	6339.6	3	2113.2	41.27**
T X C	1482.3	6	247.1	4.82**
Error	1689.6	33	51.2	
Total	10997.9	47		

	Temperature			
Container	4°C	22–23°C	32°C	Mean[a]
Glass	140	140	133.7	137.9a
Tin	140	132.5	126.2	132.9b
XT Polymer	147.5	155	158.7	153.8c
Polyethylene	153.7	157.5	172.7	161.3d
Mean	145.3A[a]	146.3A	147.8A	

** Significant at the 1% probability level.
[a] Means followed by the same letters do not differ significantly at the 1% probability level by Duncan's Multiple Range Test (Duncan, 1955).

to the USDA grading procedure used by the maple industry (Willits and Underwood, 1961), but also visually by MacAdam's numerical color scale (MacAdam, 1943). This is a series of 45 plastic plates arranged in order of increasing color from very light amber to very dark amber, numbered by fives from 0 to 220. On this scale the USDA Grade ranges are ⩽ 110, AA; 115–140, A; 145–165, B; and > 165, Unclassified. This scale enables the recording of color changes within the color grades designated by the USDA grading standard color plates. Samples contained in the square bottles used in the USDA classifier were compared visually with the MacAdam plates. Flavor was judged by two of the authors, fully familiar with maple flavor characteristics. Brix values were measured with an Abbe-type refractometer with a Brix sugar scale.

RESULTS & DISCUSSION

BRIX VALUES for the sirups were 67.1, 69.8, 68.2 and 69.1 respectively. The visual color evaluations of the stored sirups are recorded in Table 1. There are no tabulations for flavors of the sirups because there was no significant change in the flavor characteristics of the four sirups during the storage under the various conditions of the experiment which could be ascribed to the container type. All samples of the darker sirups (Sample 3 and Sample 4) at the highest storage temperature developed an off-flavor which was judged not to affect salability of the sirup. No changes in Brix values were noted.

A preliminary analysis of variance including all interactions showed the container to have the greatest influence on sirup darkening (F=136.2). The significant effect of sirup (F=30.8) was found to reside entirely in sirup No. 1, which darkened significantly more than the others. The container-temperature interaction was the most significant (F=15.9). Therefore the data for T × S, C × S and C × S × T were pooled to provide a more stringent test of temperature and container effects and their interaction. Results are shown in Table 2. Temperature of storage, overall, is without significant effect, although interaction between the containers and storage temperature is seen to be highly significant.

Within the limits of the small number of maple sirups used for this test, highly significant differences in the darkening of the sirup in the different containers during 6 months storage were observed. Greatly increased darkening occurred in both plastic containers when compared with the tin or glass package; indeed in these plastic containers a sirup can chan sufficiently during 6 months storage fall into a lower grade, since color is grade factor. Whether this darkening o color would have an adverse effect on sales is not known. The maple sirup producer must determine for himself, based on his marketing practices and customers, whether such darkening during storage is a factor to be considered in making a decision on retail containers.

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