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Quality attributes of stored Roselle jam

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Abstract: Roselle calyces are rich in nutrient, but the utilization of its calyces in the preparation of jam is not popular in Africa. The quality attributes of stored Roselle jam from dark and light red varieties were investigated. Roselle jam was processed using the open kettle method. The processed jams were stored at ambient and cold temperatures. At two weeks interval they were evaluated for pH, titratable acidity, Vitamin C, ash, dry matter, moisture content and sensory properties for a period of six weeks. pH of stored Roselle jam was more pronounced at ambient temperature. The moisture content of Roselle jam from dark-red Roselle calyx under cold storage was significantly higher than other jam samples at 2nd, 4th and 6weeks. The dry matter content of stored Roselle jams was less than 72% with Roselle jam processed from light red variety and stored under cold temperature being significantly higher than other jam samples at 2nd and 4th week Titratable acidity increased with increase in period of storage in respective of storage temperature. The ash contents of Roselle jam decreased significantly at $p<0.05$ with increase in storage period. Vitamin C at ambient temperature for both light red and dark red Roselle jam was significantly lower than the cold temperature at $p < 0.05$. The sensory scores of Roselle jam processed from both varieties were generally high. In conclusion Roselle jams prepared from either dark or light red varieties and stored for six weeks at ambient and cold temperatures are still acceptable

Keywords: Roselle, sensory, jam, calyces, processed

Introduction

Fruits and vegetables are important in human nutrition and commerce; however, they are seasonal and highly perishable and need to be processed into more stable forms such as jams, jellies and juice so as to derive their maximum benefits (Woodroof and Luh, 1986).

The Roselle (*Hibiscus sabdariffa L*) is a member of the family *Malvaceae* to which okra, cotton and kenaf belong. The flowers of Roselle are generally small. Both the leaves and the fleshy base of the flower (the calyx) are employed in the preparation of soups and sauces. The vegetable is a popular diet during the rainy season. Roselle calyx is a cheap source of vegetable protein, fat and minerals therefore its consumption should be encouraged in order to avoid nutrition deficiency diseases such as night blindness, scurvy and rickets (Babalola *et al.*, 2001).

In Africa, the utilization of Roselle is not popular except in the preparation of sorrel drink popularly known as 'zobo' drink. One of the attractive and effective means of Roselle utilization is jam processing (Desnosier, 1970).

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Jam is a means of preserving fruits, the high sugar content of jam does not allow bacteria, yeast and moulds to grow and also, prevent other spoilage. This means that the nutritional qualities of the fruits can be maintained at the same time as providing tasty products.

This work is therefore aimed at evaluating the physicochemical and consumer acceptability of stored Roselle jam at two temperature regimes

Materials and Methods

Roselle samples

Fresh samples of Roselle (*Hibiscus sabdariffa l.*) calyces of red and dark red varieties were obtained from the experimental farm of the Institute of Agricultural Research and Training (I. A. R. and T.), Moor Plantation, Ibadan. The fresh samples were over dried at 55^0C for 24hrs to obtain the dried calyx.

Processing of Roselle jam

Roselle jams from fresh and dry calyces were prepared by the open kettle methods (Molys *et al.,* 1962). Fresh Roselle calyces were harvested and sorted to remove damaged ones from the clean ones. 200 g of fresh and dry Roselle calyces were washed in water to remove dirty materials. The washed samples both dry and wet roselle calyces were parboiled for 20 mins. After parboiling the samples were independently blended in a high-speed blender for 10 mins. The blended calyces were boiled to evaporate most of the water. Granulated sugar was later added at intervals of 15 mins with constant stirring while boiling continued until desired soluble solid was attained. The Roselle jam was filled hot into sterilized bottles leaving a minimum headspace. The lid was put on and allowed to cool. The processed Roselle jam were stored at 2 different temperature, cold (8 ± 2^oC and ambient (27 ± 2^oC

Chemical analysis of Roselle jam

Determination of ascorbic acid

Ascorbic acid was determined using the procedure described by Kirk and Sawyer (1991). Standard indophenol's solution was prepared by dissolving 0.05 g 2, 6-dichloro Indophenol in water diluted to 100 ml and filtered. To standardize, 0.053g of ascorbic acid was dissolved in 90 ml of 20% metaphosphoric acid and diluted with water to 100 ml. 10 ml of this solution was pipette into a small conical flask and titrated with indophenol's solution until a faint pink colour persists for 15 seconds. 2 ml of the extracted juice from the calyces was pipette into a conical flask and 5 ml of 20% metaphosphoric acid (as stabilizing agent) was added and made up to 10 ml mark with water. It was titrated with the indophenols solution a faint pink colour persists for 15 seconds. The vitamin content in the calyces was calculated

$$\text{Vitamin C in mg/100g} = \frac{\text{Titre value x 0.212 x 100}}{\text{Wt of sample}}$$

pH determination

The pH meter (model BA 350 EDT instruments) was standardized with standard buffer solution 4.0 and 7.0. The pH was measured by inserting directly the electrodes into 10 ml beaker containing the sample.

Determination of titratable acidity

Titratable acidity was determined according to the method described by Ruck (1969). 1g of blended portion of Roselle jam sample were weighed and put into 50 ml centrifuge tube respectively. 10 ml of distilled water was added to each tube to dissolve each respectively and then flitted. 1 ml aliquot of each solution was taken into another 50 ml centrifuge tube and 10 ml of distilled water added to dilute the sample because it is highly colored. 10 ml of the diluent was titrated against 0.1N NaOH solution using phenolphthalein (2 drops) indicator percentage titratable acidity was calculated.

Determination of dry matter and moisture content

Two miliitres of each sample was measured into a previously weight crucible, dry over water for some time. The crucible plus sample taken was then transferred into the oven set at 100^0C to dry to a content weight for 24 hour over night. At the end of 24 hours, the crucible plus sample was removed from the oven and transfer to dessicator cooled for ten mins and weighed.

If the weight of empty crucible is W_0

Then, the weight of crucible plus sample is W_1

Weight of crucible plus oven dried sample is W_3

$$\% \text{ Dry matter} = \frac{W_3 - W_0}{W_1 - W_0} \times \frac{100}{1}$$

$$(\% \text{ Moisture}) = \frac{W_1 - W_3}{W_1 - W_0} \times 100$$

% Moisture Content = 100 - % DM

Determination of ash

One gram of the samples was weighed accurately into a porcelain crucible. This was transferred into a muffle furnace set at 55^0C and left for about 4hours. About this time it had turned into white ash. The crucible and its content were cooled to about 100^0C in air then to room temperature in desiccators and weighed. (A.O.A.C., 1984). The percentage ash was calculated from the formula below

$$\% \text{ Ash content} = \frac{\text{weight of Ash}}{\text{Original weight of sample}} \times \frac{100}{1}$$

Sensory evaluation

Sensory evaluation was carried out on the jam samples as described by Larmond (1977) using 10 panelists to asses the quality of Roselle jam with regard to their Colour, flavour, taste, texture and overall acceptability.

Statistical analysis

Data obtained were subjected to analysis of variance using Randomized complete block design and their means were separated by Duncan multiple range test (Duncan 1955).

Results and Discussion

Table 1 reveals the pH of stored Roselle jam processed from fresh and dry Roselle calyces of dark and light red varieties . Generally, the pH of stored Roselle jam in respective of the variety and storage conditions, decreased as the period of storage increased. This drop in pH was more pronounced at ambient temperature. This observation may be due to greater rate of carbohydrate fermentation as a result of favourable temperature for microbial activities (Fasoyiro *et al*., 2005: Ashaye *et al*., 2006). This result are within the range typical of table jams (Aina and Adesina, 1991)

Moisture and dry matter levels of any food material is a measure of the longevity or life span of the food. It indicates how long a food material can be stored without becoming mouldy (Fellows, 2000). Tables 2 and 3 depicts the moisture and dry matter contents of Roselle jam processed from fresh and dry calyces of dark and light red varieties. The moisture content of Roselle jam from dark-red Roselle calyx under cold storage was significantly higher than other Roselle jam samples at 2nd, 4th and 6weeks of storage. The dry matter content of stored

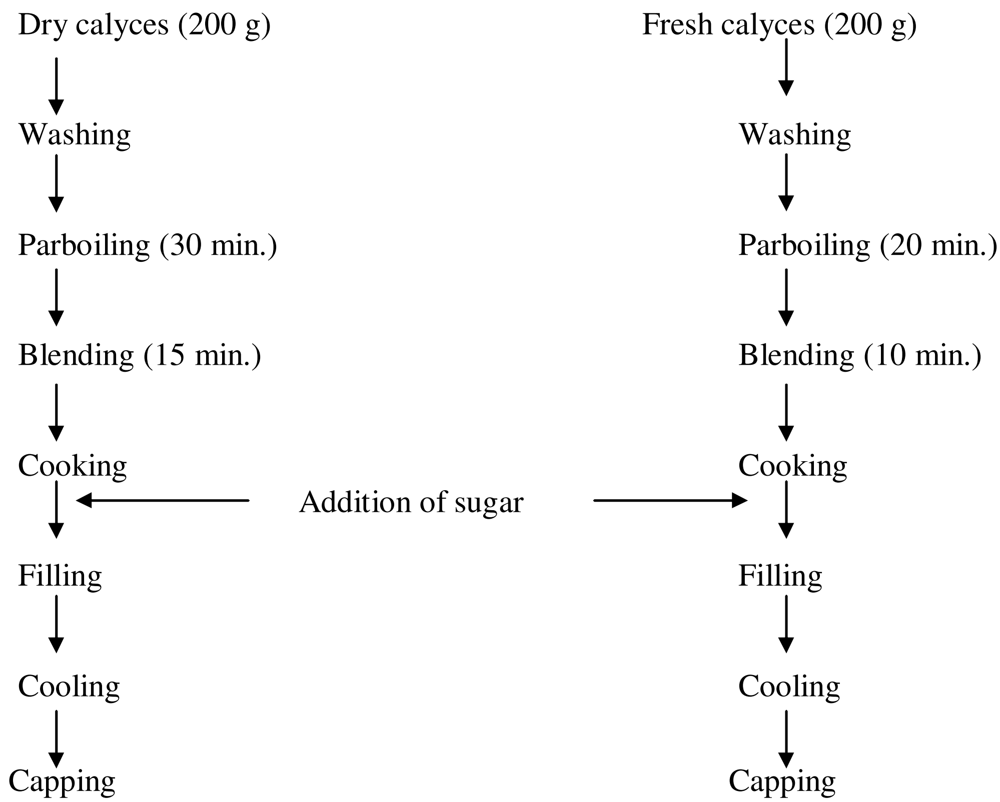

Figure 1. Flow diagram for the preparation of Roselle jam

Roselle jams was less than 72% with Roselle jam processed from light red variety and stored under cold temperature being significantly higher than other jam samples at 2nd and 4th week of storage. There was also no definite pattern in the dry matter content of the jams. Fluctuations in the moisture and dry matter contents may also be due to the activity of microorganisms and catabolic enzymes produced by them (Ashaye *et al*., 2006)

Table 4 shows the titratable acidity of Roselle jam processed from fresh and dry Roselle calyces of dark and light red varieties stored for a period of 6 weeks at ambient and cold temperature conditions. In all the Roselle jam samples, titratable acidity increased with increase in period of storage in respective of storage temperature. This increase may be due to the presence of acidophiles in the jam samples

In Table 5, it could be observed that vitamin C at ambient temperature for both light red and dark red Roselle jam was significantly lower than the cold temperature at $p < 0.05$. it decreased throughout the storage period and vitamin C values for Roselle jam processed from dry Roselle calyx was lower compared to the Roselle jam processed from fresh Roselle calyx due to fact that, some of the ascorbic acid would have been lost during the drying process.

Ash content gives an indication of minerals present in a particular food sample and it is very important in many biochemical reactions which aids physiological functioning of major metabolic processes in the body. In table 6, the ash contents of Roselle jam progressively decreased significantly at $p<0.05$ with increase in storage period. The rate of decrease was more pronounced at ambient temperature than at cold temperature with light red

Table 1. pH of Jam processed from fresh and dry roselle calyx stored at ambient and cold temperature conditions

Sample	0 **week**	2 **weeks**	4 **weeks**	6 weeks
JFDRA[1]	2.82[g]	2.79[h]	2.75[g]	2.59[g]
JFDRC[2]	2.91[f]	2.86[g]	2.82[f]	2.68[e]
JFLRA[3]	2.93[f]	2.88[f]	2.83[f]	2.63[f]
JFLRC[4]	3.03[e]	2.95[e]	2.89[e]	2.73[d]
JDDRA[5]	3.26[d]	3.21[d]	3.18[d]	3.13[b]
JDDRC[6]	3.46[c]	3.28[c]	3.24[c]	3.18[a]
JDLRA[7]	3.60[b]	3.55[b]	3.51[b]	2.98[c]
JDLRC[8]	3.74[a]	3.68[a]	3.63[a]	3.12[b]

Means in the same column followed by the same letter are not significantly different from each other at $p < 0.05$

Key:

JFDRA[1] – Roselle Jam from Fresh Dark Red Roselle calyx stored at Ambient temperature condition
JFDRC[2]– Roselle Jam from Fresh Dark Red Roselle calyx stored at Cold temperature condition
JFLRA[3]– Roselle Jam from Fresh Light Red Roselle calyx stored at Ambient temperature condition
JFLRC[4]– Roselle Jam from Fresh Light Red Roselle calyx stored at Cold temperature condition
JDDRA[5]– Roselle Jam from Dry Dark Red Roselle calyx stored at Ambient temperature condition
JDDRC[6]– Roselle Jam from Dry Dark Red Roselle calyx stored at Cold temperature condition
JDLRA[7]– Roselle Jam from Dry Light Red Roselle calyx stored at Ambient temperature condition
JDLRC[8]– Roselle Jam from Dry Light Red Roselle calyx stored at Cold temperature condition

Table 2. Moisture content of Jam processed from fresh and dry roselle calyx stored at ambient and cold temperature conditions

Sample	0 week (%)	2 weeks (%)	4 weeks (%)	6 weeks (%)
JFDRA	34.03[b]	33.88[b]	33.95[b]	34.09[b]
JFDRC	31.39[e]	34.13[a]	34.38[a]	34.87[a]
JFLRA	36.13[a]	32.78[c]	32.93[c]	33.15[d]
JFLRC	33.15[c]	30.38[f]	30.65[g]	30.98[g]
JDDRA	30.28[f]	31.93[d]	32.06[d]	33.49[c]
JDDRC	28.74[h]	29.99[g]	30.69[f]	31.72[f]
JDLRA	31.73[d]	30.58[e]	30.78[e]	30.26[h]
JDLRC	29.78[g]	28.97[h]	29.12[h]	32.83[e]

Means in the same column followed by the same letter are not significantly different from each other at $p < 0.05$. Refer to Table 1 for key to abbreviations for the sample.

Table 3. Dry matter of Jam processed from fresh and dry roselle calyx and stored at ambient and cold temperature conditions

Sample	0 Week (%)	2 Weeks (%)	4 Weeks (%)	6 Weeks (%)
JFDRA	65.99[g]	66.13[g]	66.03[g]	65.95[g]
JFDRC	68.64[d]	65.87[h]	65.66[h]	65.15[h]
JFLRA	63.88[h]	67.26[f]	67.12[f]	66.89[e]
JFLRC	66.83[f]	67.62[e]	69.36[b]	69.04[b]
JDDRA	69.75[c]	68.08[d]	67.96[c]	66.54[f]
JDDRC	71.29[a]	70.04[b]	69.33[c]	68.28[c]
JDLRA	68.29[e]	69.44[c]	69.25[d]	69.76[a]
JDLRC	70.26[b]	71.06[a]	70.88[a]	67.21[d]

Means in the same column followed by the same letter are not significantly different from each other at $p < 0.05$. Refer to Table 1 for key to abbreviations for the sample.

Table 4. Titratable acidity (TTA) of Jam processed from fresh and dry roselle calyx stored at ambient and cold temperature conditions

Sample	0 Week (%)	2 Weeks (%)	4 Weeks (%)	6 Weeks (%)
JFDRA	1.71[h]	1.76[h]	1.80[e]	2.13[a]
JFDRC	1.74[f]	1.78[g]	1.93[b]	1.97[c]
JFLRA	1.72[g]	1.87[c]	1.85[d]	1.86[g]
JFLRC	1.76[e]	1.83[ae]	1.89[c]	1.89[f]
JDDRA	1.78[c]	1.79[f]	1.81[e]	1.96[c]
JDDRC	1.77[c]	1.93[a]	1.95[a]	1.99[b]
JDLRA	1.84[b]	1.86[d]	1.88[c]	1.91[e]
JDLRC	1.86[a]	1.88[b]	1.92[b]	1.93[d]

Means in the same column followed by the same letter are not significantly different from each other at $p < 0.05$. Refer to Table 1 for key to abbreviations for the sample.

Table 5. Vitamin C content of Jam processed from fresh and dry roselle calyx stored at ambient and old temperature conditions

Sample	0 Week (mg/100g)	2 Weeks (mg/100g)	4 Weeks (mg/100g)	6 Weeks (mg/100g)
JFDRA	28.82[a]	26.82[a]	24.62[a]	23.06[a]
JFDRC	26.76[b]	23.62[b]	21.52[b]	19.94[b]
JFLRA	23.25[c]	21.28[c]	19.96[c]	17.88[c]
JFLRC	21.88[d]	19.76[d]	18.13[d]	16.08[d]
JDDRA	13.95[g]	13.08[e]	12.88[e]	11.78[e]
JDDRC	13.82[h]	12.96[f]	12.72[f]	11.75[f]
JDLRA	14.82[e]	12.88[g]	11.63[g]	10.84[g]
JDLRC	14.16[f]	12.78[h]	10.94[h]	9.84[h]

Means in the same column followed by the same letter are not significantly different from each other at $p < 0.05$. Refer to Table 1 for key to abbreviations for the sample.

Table 6. Ash content of Jam processed from fresh and dry roselle calyx stored at ambient and cold temperature conditions

Sample	0 Week (%)	2 Weeks (%)	4 Weeks (%)	6 Weeks (%)
JFDRA	0.81[a]	0.77[a]	0.74[a]	0.69[a]
JFDRC	0.73[c]	0.69[b]	0.66[b]	0.63[b]
JFLRA	0.69[d]	0.63[d]	0.61[c]	0.57[c]
JFLRC	0.65[f]	0.58[f]	0.56[d]	0.54[d]
JDDRA	0.79[b]	0.68[b]	0.56[d]	0.52[e]
JDDRC	0.72[c]	0.65[c]	0.53[e]	0.49[f]
JDLRA	0.67[e]	0.61[e]	0.50[f]	0.46[g]
JDLRC	0.63[f]	0.55[g]	0.46[g]	0.41[h]

Means in the same column followed by the same letter are not significantly different from each other at $p < 0.05$. Refer to Table 1 for key to abbreviations for the sample.

Table 7. Sensory evaluation of Roselle Jam stored at '0' week under ambient and cold temperature conditions

	Colour	Taste	Flavour	Texture	General Acceptability
JFDRA	7.4^{ab}	7.3^{ab}	7^{ab}	6.3^{ab}	6.7^{abc}
JFDRC	6.6^{abc}	6.5^{abc}	5.4^{ab}	5.3^{b}	7.3^{ab}
JFLRA	8.1^{a}	7.5^{a}	7.1^{a}	7.6^{ab}	8.1^{a}
JFLRC	7.4^{ab}	7.5^{a}	7^{ab}	5.9^{b}	6.5^{abc}
JDDRA	6.8^{abc}	7.3^{ab}	6^{ab}	6.2^{ab}	5.9^{bc}
JDDRC	5.8^{bcd}	6^{bc}	5.7^{ab}	4.9^{b}	4.8^{c}
JDLRA	5.6^{cd}	6.2^{abc}	5.9^{ab}	5.3^{b}	6.1^{bc}
JDLRC	4.7^{d}	5.9^{c}	6^{ab}	5.5^{b}	5.1^{c}

Means in the same column followed by the same letter are not significantly different from each other at $p < 0.05$. Refer to Table 1 for key to abbreviations for the sample.

Table 8. Sensory evaluation of roselle jam stored for 2 weeks under ambient and cold temperature conditions

	Colour	Taste	Flavour	Texture	General Acceptability
JFDRA	7.2^{a}	7.7^{a}	7.9^{ab}	7.4^{a}	7.9^{a}
JFDRC	7.2^{a}	7.7^{a}	8.4^{a}	8.1^{a}	8.1^{a}
JFLRA	7.3^{a}	7.8^{a}	6.9^{b}	7.0^{a}	7.5^{a}
JFLRC	7.8^{a}	7.1^{a}	7.6^{ab}	7.4^{a}	7.3^{a}
JDDRA	5.1^{b}	5.0^{b}	4.3^{c}	4.6^{b}	4.7^{bc}
JDDRC	4.8^{bc}	4.3^{b} 4.0^{b}	4.3^{c}	3.7^{bc}	4.6^{bc}
JDLRA	4.7^{bc}	4.4^{b}	3.8^{c}	3.3^{c}	4.1^{c}
JDLRC	4.0^{c}		3.9^{c}	4.3^{bc}	5.0^{c}

Means in the same column followed by the same letter are not significantly different from each other at $p < 0.05$. Refer to Table 1 for key to abbreviations for the sample.

Table 9. Sensory evaluation of roselle jam stored for 4 weeks under ambient and cold temperature conditions

	Colour	Taste	Flavour	Texture	General Acceptability
JFDRA	6.9^{ab}	7.1^{ab}	6.1^{ab}	7.0^{a}	6.0^{abc}
JFDRC	8.0^{a}	7.3^{a}	6.3^{a}	6.7^{ab}	7.2^{a}
JFLRA	7.3^{a}	7.3^{a}	6.1^{ab}	6.9^{a}	6.8^{ab}
JFLRC	6.9^{ab}	6.6^{abc}	5.9^{ab}	5.9^{ab}	6.6^{abc}
JDDRA	5.2^{cd}	5.0^{cd}	6.3^{ab}	6.1^{ab}	5.3^{c}
JDDRC	4.5^{d}	6.1^{abcd}	4.8^{b}	5.2^{b}	5.7^{bc}
JDLRA	4.8^{d}	5.1^{d}	6.0^{ab}	5.5^{ab}	5.8^{bc}
JDLRC	6.0^{bc}	5.9^{bcd}	5.8^{ab}	5.5^{ab}	5.8^{bc}

Means in the same column followed by the same letter are not significantly different from each other at $p < 0.05$. Refer to Table 1 for key to abbreviations for the sample.

roselle jam stored at cold temperature being significantly lower at 6 weeks. Lower ash contents is due to increased activities of microorganism utilizing the minerals for growth (Ashaye *et al*., 2006)

It is apparent from tables 7, 8, 9 and 10 that the sensory scores given to Roselle jam processed from fresh and dry Roselle calyces of dark and light red varieties were generally high although there were

Table 10. Sensory evaluation of roselle jam stored for 6 weeks under ambient and cold temperature conditions

	Colour	Taste	Flavour	Texture	General Acceptability
JFDRA	6.9^{ab}	7.1^{a}	7.0^{a}	6.4^{ab}	7.3^{a}
JFDRC	7.7^{a}	7.4^{a}	7.0^{a}	7.2^{a}	7.4^{a}
JFLRA	5.9^{bc}	6.6^{a}	5.9^{a}	6.0^{ab}	6.1^{ab}
JFLRC	6.4^{abc}	6.6^{a} 7.0^{a}	5.8^{a}	6.0^{ab}	6.5^{ab}
JDDRA	7.1^{ab}	7.3^{a} 6.4^{a}	6.4^{a}	6.0^{ab}	7.7^{a}
JDDRC	7.1^{dab}	6.1^{a}	6.9^{a}	6.0^{ab}	6.9^{ab}
JDLRA	6.0^{bc}		5.6^{a}	5.3^{b}	5.4^{b}
JDLRC	5.3^{c}		6.1^{a}	6.0^{ab}	5.3^{b}

Means in the same column followed by the same letter are not significantly different from each other at $p < 0.05$. Refer to Table 1 for key to abbreviations for the sample.

significant differences in their sensory parameters. At 6 weeks, Roselle jam from fresh and dry calyces at both temperatures had similar acceptability although Roselle jam from fresh dark calyx had higher score in quality attributes. This could be due to varietal differences

Conclusion

It can therefore be deduced that Roselle jams prepared from either dark or light red varieties and stored for six weeks at ambient and cold temperatures are still acceptable for consumption. Although it is advisable to process Roselle jam from the fresh calyx so as to reduce the rate of Vitamin C loss. It is also better stored under cold temperature conditions to slow down deterioration

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