Additives for Quality Maintenance

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ABSTRACT

In the transport and storage of edible oils, oxidation and trace metals contamination are still problems today. A great deal of published information exists on the use of antioxidants and sequestering agents to reduce or prevent deterioration. Some recent information on their effects, especially in the transport operation, is presented here.

A recent paper by Pongracz (1984) serves to remind us of the effect of antioxidants in lard. The results are shown in Figure 1 for the customary synthetic antioxidants and for the tocopherols.

The graph plots protection factor against concentration for stability tests in the Rancimat at 120 C. The most usual legally permitted maximum concentration is 200 ppm. At this level octyl gallate and TBHQ are more effective than BHA and BHT, while the tocopherols also provide good protection. It should be remembered that gallate antioxidants are liable to produce discoloration in the presence of iron. The γ and d-tocopherol continue to show increased protection at higher concentrations.

The effects of synthetic antioxidants and of chelating agents alone and in combination in vegetable oils are illustrated in Tables I to IV and in Figures 2 and 3 (1).

In accelerated tests in vegetable oils, the synthetic antioxidants show relatively little effect (Table 1). However, as a matter of practical experience they do provide some protection against flavor deterioration in palm oil during storage.

The effect of citric acid in palm oil is shown in Table II.

This table shows only a moderate effect, presumably because the level of trace metals in the refined oil is low. The real benefit is obtained when metal contamination is significant, as shown in the model experiments of Jakubowski (3), shown in Figure 4.

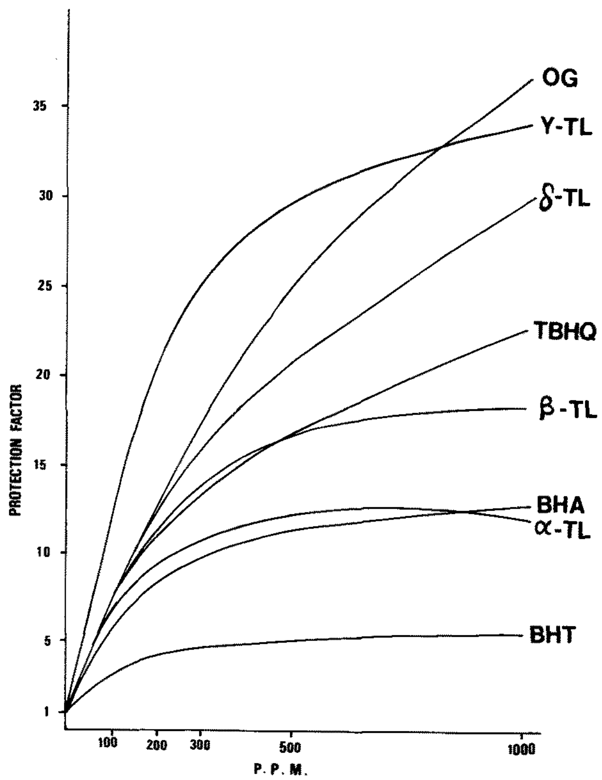

FIG. 1. Effects of antioxidants in lard (1).

TABLE I

Antioxidants in RBD Palm Oil

	TBHQ	BHA	BHT
Nil	52	54	52
50 ppm	72	55	55
100 ppm	78	57	58

TABLE II

Citric Acid in RBD Palm Oil

Addition	Rancimat stability (hours at 100 C)
Nil	52
50 ppm	60
100 ppm	62
200 ppm	64

TABLE III

Citric Acid and Lecithin in Crude Palm Oil

Addition	Rancimat stability (hours at 100 C)
Control	47
50 ppm lecithin	48
100 ppm lecithin	52
200 ppm lecithin	58
Control	52
50 ppm citric acid	71
100 ppm citric acid	72
200 ppm citric acid	79
Control	51
200 ppm lecithin + 50 ppm citric acid	73
200 ppm lecithin + 100 ppm citric acid	75
200 ppm lecithin + 200 ppm citric acid	87

TABLE IV

TBHQ and Citric Acid in RBD Palm Oil

Addition	Rancimat stability (hours at 100 C)
Nil	56
50 ppm TBHQ + 25 ppm citric acid	79
100 ppm TBHQ + 50 ppm citric acid	92
200 ppm TBHQ + 100 ppm citric acid	104

Table III shows the effect of lecithin alone and in combination with citric acid.

The synergistic effect of synthetic antioxidant and chelating agent is demonstrated in Table IV.

Figure 2 shows the effect of this combination in laboratory storage at 60 C of crude palm stearin. The increase in peroxide value is almost completely inhibited.

The validity of accelerated oxidation tests ideally should be proven by fullscale trials under real life conditions.

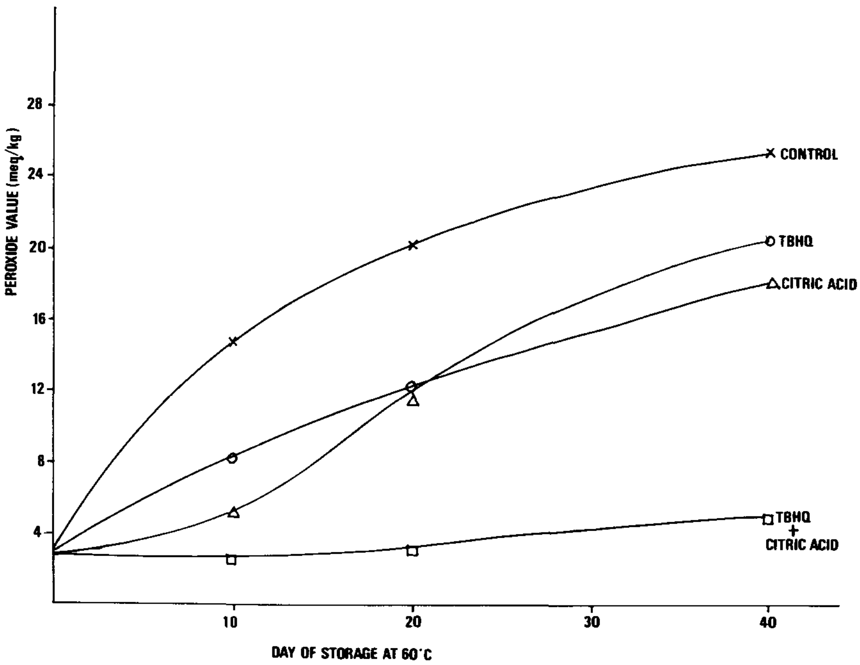

FIG. 2. Effects of TBHQ and citric acid on the oxidation of crude palm stearin.

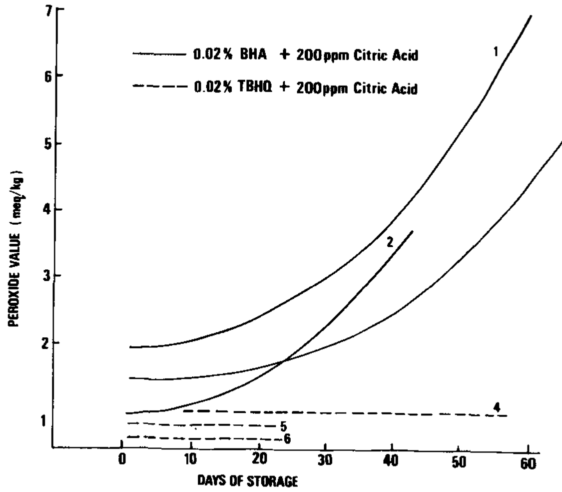

FIG. 3. Effect of antioxidants on palm olein in bulk storage.

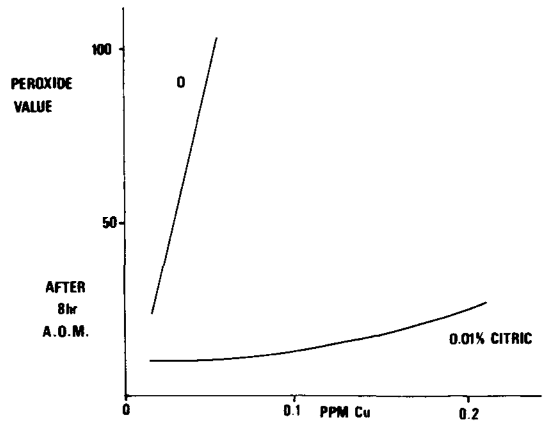

FIG. 4. Copper in H.R.S.O.

The last set of results, presented in Figure 3, is therefore of particular importance. They represent quality analyses carried out on refined palm olein sampled from a bulk storage tank in Australia during up to 2 mo storage (4). The olein had been shipped from Malaysia after dosage with antioxidant and citric acid, and Figure 3 summarizes the results for a number of shipments. The protection against oxidation with TBHQ and citric acid is complete and long lasting.

REFERENCES

1. Pongracz, G. (1984) γ Tocopherol as Natural Antioxidant. Paper presented at D.G.F., September Meeting, Regensburg.
2. Gapor, Abdul (1983, 1984) PORIM Annual Research Reports.
3. Jakubowski, M.A., and Z. Rudzka (1973) In Third International Symposium Metal Catalyzed Lipid Oxidation, p. 208. Institut des Corps Gras Paris.
4. Berger, K.G. (1983) In Fats for the Future, p. 91, Ed. S.G. Brooker, Duromark Publishing, Auckland, New Zealand.

Session VIII

The following questions, answers and comments were presented during the informal discussion at the conclusion of the day's plenary lectures.

Q: Could you please explain why U_3 is so low and SU_2 almost unaltered in palm oil after randomization?

Duns: The U_3 is reduced in randomization. The anomaly is in the decrease of the S_3 which is the result of a slight occurrence of directed interesterification.

Q: To what extent are randomized palm olein and palm oil used in margarines?

Duns: The usefulness of interesterified palm oil is to some extent restricted by the S_3 increase. Its use in table margarines is not more than 10-15%. Its usefulness can be increased when interesterified with other liquid and lauric oils. In interesterified palm olein, the ratio of symmetrical to asymmetrical triglycerides is increased from 5:1 to 8:1, which is an advantage for use in table margarines. In practice, however, palm olein is not often used because of its premium price over palm oil or palm stearin.

Q: Do you think hydrogenated palm olein or hydrogenated palm oil containing high *trans* acids can be used in enhanced quantity (50-70%) in vanaspati formulation along with other selectively hydrogenated liquid oils?

Kheiri: The products using 100% hydrogenated palm olein can be made by hydrogenating it under high "*trans* isomerization" conditions. The total *trans* fatty acid content is 15-18%.

Q: Is interesterification of blends of palm oil or palm olein with selectively hydrogenated oils likely to give much better products than the blends of hydrogenated palm or hydrogenated palm oil and other hydrogenated liquid oils in respect of granular structure and consistency?

Kheiri: Blends of hydrogenated palm products with hydrogenated liquid vegetable oils will give better products in terms of granularity than hydrogenated palm oil.

Q: You mentioned that interesterification affects the crystallization behavior of palm oil. Could you please elaborate on the main reasons for the change in crystallization behavior on interesterification?

Kheiri: The difference is due to the change in glyceride types and their amount due to interesterification.

Q: To use palm oil in dairy products, is it necessary to treat the oil through the so-called "homogenation process" before use and if so, why? Could you also describe the so-called homogenization process of palm oil?

Kheiri: Using about 0.2% of seeding material consisting of high melting triglycerides, palm oil can be crystallized to a single phase.

Q: For producing vegetable ghee having formulations of palm and soybean oil, should the blending of both oils be made before or after hydrogenation to get end products of the following specifications: uniform consistency in texture with respect to crystal formation, and least possibility of developing separation into liquid-solid phases?

Kheiri: There is no difference in the consistency and crystal structure between the products made from the blends before or after hydrogenation.

Q: What ratio of spent to fresh catalyst is used to get the hydrogenated fat with a higher percentage of *trans* isomers?

Kheiri: Usually 10% of the spent catalyst is added to the fresh catalyst. However, the actual level is worked out by the user himself after some trials.

Q: For the dry fractionation of palm oil, do you use long time or short time crystallizers?

Traitler: Six to 15 hrs is proposed if diglyceride level is low; 6 hrs if diglyceride level is high.

Q: What about distribution between cooling and maturation time?

Traitler: We do not want too fine crystals. A relatively short cooling time is recommended, and this is easy to obtain in a pilot plant. We should aim for little temperature gradient. Cooling down may work for 10-20% of the total crystallization time.

Q: Was the mango stearin obtained by wet fractionation? What was the solvent used?

Traitler: Dry fractionation, but the mango oil has to be well refined.

Q: What will be the appropriate proportions of mango stearin and PMF to obtain good CBS if not CBE?

Traitler: 10-20% mango, 89-90% PMF.

Q: Do you have any idea about Mowrah oil stearin (LSF) that can be blended with PMF?

Traitler: Yes, very interesting, we work on that. But at present we have no exact data available.

Q: An end user of palm oil requires specifically that the palm oil be refined by the chemical method, i.e. NBD and not RBD. How can the customer know he is actually receiving NBD and not RBD? Are there any analytical methods that can prove the processing of the palm oil definitely has been by the chemical refining method?

Traitler: The customer must first of all believe what the producer tells him but of course he will never be sure. Dimer formation occurs at higher deodorization temperature (260 C-270 C), and it would perhaps be worth adding that into the specification, provided reliable reference values are established and the detection method is widely used. Residues of soap may be an indication, but this is also tricky. The ratio of residual carotene over UV absorption may give us a guideline. Increased amount of unsymmetrical triglycerides may indicate high temperature treatment—again reference values have to be established and high temperature is not the only cause for isomerization.

Comment, Vernon Young: There would be a difference in trace iron content: 0.15 ppm FE by NBD; 0.25-0.5 ppm Fe by physical refining. Dr. Traitler added that it also depends on the refining. Normally NBD has lower value of Fe.

Q: What is your idea about the properties of the mid-fraction from commercial palm stearin, if one intends to make PMF type product? Does the fatty acid profile of a diglyceride show any different kind of effect on the thermal properties of cocoa butter?

Mori: The properties of PMF from palm stearin should be all right provided the quality of palm stearin used is acceptable. The fatty acid profile of the diglycerides may show different effects. Studies on this aspect are being conducted.

Q: In your paper, you stated that diglycerides influence the polymorphic changes and rate of crystallization of fat. Could you please explain the reasons why diglycerides have these effects?

Mori: We regret we do not know the answers to these yet.

Q: Is sal stearin/mid-fraction used in chocolate formulation in the U.S.A.?

Pease: Sal fats are not used in any form in the United States at this time, to our knowledge. First, sal fat is not an economical alternative to currently used cocoa butter substitutes. Second, the standard of identity for chocolate forbids the use of any vegetable fat other than cocoa butter in products labeled "chocolate" or "milk chocolate."

Q: Do you think that kokum fat can be fractionated to obtain kokum mid having satisfactory thermal properties, thereby making it suitable for blending with PMF?

Pease: Fractions of kokum which are rich in symmetrical mono-oleo di-saturated triglycerides have been blended with PMF to formulate CBE.

Q: Do you think that completely hydrogenated palm olein when interesterified with olive oil or triolein can yield a good quality CBS after fractionation?

Pease: We have no information regarding the use of olive oil in conjunction with palm or other vegetable oil to formulate CBS.

Q: Can the speaker give us some idea of the specifications (m.p.,

SFC, FAC, etc.) required for chocolate coating fat to be used in ice creams (low temperature consumption products)? Which of the CBE or CBS shown would satisfy these specifications best? We often find the ice cream chocolate coatings from our local manufacturers to have a very waxy mouthfeel.

Pease: It is my experience that a low melting fat such as refined, bleached and deodorized coconut oil or palm kernel oil is the most widely used fat for ice cream coatings. The melting point of RBD coconut oil is about 76 F while RBD palm kernel oil melts at about 80 F.