Antioxidant activity of the polyamines spermine and spermidine in soybean oil

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INTRODUCTION

Lipid oxidation reactions are frequent in foods, and are often associated with food deterioration. Even though it starts in the lipid fraction, eventually other food components are affected, changing several desirable properties, among them, sensory, nutritional and functional qualities. Furthermore, undesirable compounds can be formed and affect consumers’ health. It also limits the shelf life of lipids and of foods containing significant amounts of lipids. Soybean oil is widely used in Brazil because of its high availability and low price. Since it contains high levels of unsaturated fatty acids, it is susceptible to oxidation. Therefore, it is an interesting matrix to investigate ways to prevent lipid oxidation, and to determine which antioxidants would be effective in preventing oxidation. Today, there is a tendency to substitute synthetic antioxidants by natural ones. Among antioxidants which are natural in biological systems, the polyamines spermine (EPM) and spermidine (EPD) play an important role. They are soluble in aqueous and organic phases what facilitates the application in different food matrices [1-3]. The objective of this study was to investigate the antioxidant activity of spermine and spermidine individually and to compare the results with those of traditional synthetic antioxidants and different combinations using Rancimat®.

MATERIALS & METHODS

Spermidine (EPD) and spermine (EPM) were purchased from Sigma Chemical Co. (St Louis, MO, USA) and BHA and BHT were from Synth (Diadema, SP, Brazil). The antioxidant free soybean oil was provided by Cargill Agrícola (Mairinque, SP, Brazil). The antioxidant activity of the compounds in antioxidant free soybean oil was determined using a Rancimat® (model 743, Metrohm, Herisau, Swiss), according to the AOCS method Cd 12b-92 [4,5]. The standard solutions were incorporated into the antioxidant free soybean oil using an ultrasound shaker (UltraSonic Cleaner, Unique, SP, Brazil). The control was also kept in the shaker for the same time period. The analyses were performed in duplicate. The experiments were performed at 110 ºC, at an air flow of 20 L/h, and 60 mL Milli-Q water was used for the collection of the volatiles. Conductivity curves versus time and the induction periods were automatically obtained. The results were expressed as protection factors (PF = ratio between the induction periods of the sample containing the antioxidant and the control sample). The results were analyzed with STATISTICA 8.0 (STATSOFT, USA), at 5% probability. The antioxidant activity of the polyamines was compared with those of the synthetic antioxidants BHA and BHT at concentrations of 0.01, 0.02, 0.03, 0.04, 0.05 and 0.06 g/100 g. The antioxidant activity of different combination of EPM, BHA, and BHT at 1:1 (v/v) was determined.

RESULTS & DISCUSSION

The antioxidant activity of the amines EPD and EPM in soybean oil was confirmed. The activity of EPM was higher compared to EPD. These results are similar to those reported by
Drolet et al. [2] and Løvaas [3], who concluded that the antioxidant activity of these compounds was associated with the number of amine groups in the molecule. There was a significant linear correlation ($R^2 = 98.16\%$) between the levels of the amines and the protection factors. Based on this result, a response surface model was generated and can be used to predict the shelf life of soybean oil at 110 °C, at concentrations from 0.0059 to 0.0341 g/100 g oil using the equation: \(PF \ (\text{protection factor}) = 2.11 + 0.59EPM + 0.30EPD\). Within the concentration range investigated, there was no synergistic effect, but an additive effect of EPD and EPM in soybean oil. The protection factor obtained for EPM was higher compared to those obtained for BHA, BHT, BHA+BHT, EPM+BHA, and EPM+BHT (Figure 1).

![Figure 1. Protection factors for soybean oil at 110 °C determined in Rancimat in the presence of different concentrations of BHA, BHT, EPM and their mixtures at 1:1.](image)

**CONCLUSION**

The polyamines EPM and EPD increased the oxidative stability of soybean oil. EPM was more effective than EPD. The polyamines EPM and EPD showed higher antioxidant activity compared to BHA and BHT. Therefore, the polyamines EPM and EPD are potent antioxidants in soybean oil and provide higher protective factors than some of the traditional synthetic antioxidants tested.

**REFERENCES**