ANTIOXIDATIVE ACTIVITY OF ETHANOL EXTRACTS FROM PLANT MATERIALS IN LARD AND BLEACHED SUNFLOWER OIL

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SUMMARY

Experiments carried out with ethanol plant extract 1 (Asclepias syriaca L.), 2 (Astragalus onobrychis L.) and 3 (Chenopodium ambrosiodes L.) applied to lard and bleached sunflower oil as substrates showed their antioxidative activity. The increase of extract concentration and the addition of citric acid or lecithin as synergists increase the inductive period. The comparison of oxidative stability of sample with 0.01% BHA, control sample and samples with the investigated extracts showed that the extract effect, even at significantly high concentration (0.2%), is several times lower than those of commercial antioxidants. The addition of synergists improves the effect of extract, but it does not change the pattern of antioxidative activity. The use of highly unsaturated substrate, completely bleached sunflower oil, indicates for plant extract 3 practically the same order of inductive periods. The mentioned decrease in differences is not caused by significant increase of antioxidative activity of the extract itself, but by lower activity of BHA in the substrate which indicates the importance of careful selection of antioxidative materials for different substrates.

Key words: Bleached sunflower oil, lard, oxidative stability, synergism

INTRODUCTION

Antioxidative stability of fats and oils is important for shelf life, quality and health acceptability of food products. Numerous publications deal with the problem of oxidation, first of all with the problem of unsaturated fatty acids, pointing out the mechanism of oxidation, antioxidants and synergist, analytics, odor and taste changes and the related health problems (Chan, 1987; Elmadfa et al., 1982; Frankel, 1985; Marklund, 1985; Porter, 1980; Rossell, 1983).

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Deceleration of oxidative processes in fats and oils is achieved by applying commercial antioxidants. Their effect can be increased by adding suitable synergists.

Most significant is the application of synthetic antioxidants which satisfy the stated requirements - the activity and price. More detailed investigations on physiological activity of synthetic antioxidants caused the regulations for their application (Branen, 1975; Federal Register, 1977; Frankel, 1985) to become more stringent and intensified investigations on antioxidants coming from natural sources.

During last few decades, especially since 1952, antioxidative materials from different sources, first of all from plants, seeds, fruits, materials from biotechnological processes and partially from living organisms were studied. A special group are substances produced by reaction of amino acids and carbohydrates (Maillard-compounds), which are present in many food products and which show clear antioxidative effects.

All these investigations showed that there is a large number of substances, prepared by different techniques from natural materials, exhibiting antioxidative activity. Nevertheless, these investigations also showed that some substances from plant material, which were used for a certain period of time, must be eliminated because harmful consequences of their application were detected. In general, it is a long way from determining antioxidative activity in a substance to its eventual application in food industry.

In this work we wanted to establish antioxidative characteristics of ethanol extracts produced from selected plant materials and synergistic activity of citric acid and lecithin when used with the selected substrates.

The antioxidative activity of ethanol extracts from three plant materials (Asclepias syriaca L., Astragalus onobrychis L. and Chenopodium ambrosiodes L.) was investigated. Lard prepared by wet procedure and sunflower oil bleached on the column with activated charcoal were used as substrates.

MATERIALS AND METHODS

Air-dried aboveground parts of plants, containing ethereal oils, which are usually followed by the presence of substances with antioxidative activity, were used as sources of natural antioxidants. Three plants were taken for experiments. Asclepias syriaca L. (milk weed), because young parts of the plant are used for food (toxic substances in milk juice are neutralized by cooking/boiling), and the roots are used for medical purposes (Hoppe, 1958). Astragalus onobrychic L. (milk vetch) is a widely distributed plant in steppe regions. Seeds of Astragalus complanatus R.Br. were investigated for antioxidative activity (Su et al., 1986). Chenopodium ambrosiodes L. (American wormseed) contains 0.25-0.30% ethereal oils and it is used for medical purposes (leaves and seeds). Previous investigations have shown that family Chenopodiaceae contains substances with antioxidative activity (Mihelić, 1958).
Extraction was carried out using Twisselmann apparatus, at first with hexane for 6 hours, to remove ethereal oils, and than with 96% ethanol for next 6 hours. After ethanol vacuum evaporation, the residue (in ethanol solution form) was used for investigation of antioxidative activity.

The lard produced by wet procedure and completely bleached sunflower oil were used as substrates for plant materials. Bleached sunflower oil can be prepared on the column with activated charcoal and vaculite (3:1) with hexane as eluent, or by mixing activated charcoal, hexane and edible refined sunflower oil in the volume ratio 1:1:1, keeping it for 24 hours, and filtering through quartz sand column. After hexane evaporation, the obtained bleached sunflower oil has no natural antioxidants and can be used as a suitable substrate for antioxidant assays, because of its low antioxidative stability. Lard and oil samples were prepared in Petri dishes, and held in dark at 60°C. Oxidative stability of samples has been followed by determination of peroxide number by Wheeler method (Wheeler, 1932) modified by Hadorn et al. (1956).

RESULTS AND DISCUSSION

In the first experiment series, ethanol extracts of all three plants were added in concentrations of 0.02% and 0.2% to lard as substrate. The results are presented in Figure 1. Pure BHA in the concentration of 0.01% was used for comparison.

![Figure 1: Changes in peroxide number of lard sample with addition of plant extract](image-url)

- K1 - control sample
- 1a, 1b - Asclepias syriaca L. extract, 0.02%, 0.2%
- 2a, 2b - Astragalus onobrychis L. extract, 0.02%, 0.2%
- 3a, 3b - Chenopodium ambrosiodes L., 0.02%, 0.2%
- BHA - 0.01%
Figure 2: Changes in peroxide number of lard sample with addition of plant extract (Asclepias syriaca L.) and synergists
K2 - control sample
1c, 1d - extract ... 0.02%, 0.2%
1e - extract 0.02% + 0.0067% citric acid, aqueous solution
1f - extract 0.015% + 0.005% powdered citric acid
1g - extract 0.15% + 0.03% lecithin
1h - extract 0.15% + 0.03% lecithin

Figure 3: Changes in peroxide number of lard samples with addition of plant extract (Astragalus onobrychis L.) and synergists
K3 - control sample
2c, 2d - extract ... 0.02%, 0.2%
2e - extract 0.02% + 0.0067% citric acid, aqueous solution
2f - extract 0.015% + 0.005% powdered citric acid
2g - extract 0.15% + 0.03% lecithin
2h - extract 0.15% + 0.03% lecithin
Figure 4: Changes in peroxide number of lard samples with addition of plant extract (Chenopodium ambrosiodes L.) and synergists
K4 – control sample
3c, 3d – extract ... 0.02%, 0.2%
3e – extract 0.02% + 0.0067% citric acid, aqueous solution
3f – extract 0.015% + 0.005% powdered citric acid
3g – extract 0.15% + 0.05% lecithin
3h – extract 0.15% + 0.03% lecithin

Figure 5:
Changes in peroxide number of sample of completely bleached sunflower oil with addition of plant extract (Chenopodium ambrosiodes L.) and synergists
K5 – control sample
3A – extract 0.15%
3B – extract 0.15% + 0.05% lecithin
3C – extract 0.015% + 0.005% citric acid
samples with 0.02% extract (1a, 2a, 3a) show a slight (moderate) increase of oxidative stability, and those with 0.2% have the inductive period increased for 2-3 times compared with control sample.

For plant extract 1 (Asclepias syrtaca L.), synergism or citric acid and lecithin from soybean oil was analyzed too (Figure 2). The addition of 0.005% powdered citric acid (1f) shows good synergism, much better in relation to the addition of aqueous solution of citric acid (1e). The addition of 0.05% lecithin with 0.15% extract (1g) shows an increase of oxidative stability to the sample with 0.2% extract (1d). Sample 1h behaved in a similar fashion.

Ethanol plant extract 2 (Astragalus onobrychis L.) shows very similar effect (Figure 3), whereas the curves for samples with 0.05% and 0.03% of added lecithin (2 g, 2h) are practically equal, although the oxidative stability of the sample with 0.15% extract and lecithin is significantly higher than that of the sample with only 0.2% extract (2d).

By adding 0.005% powdered citric acid (sample 2f) and 0.015% extract, the oxidative stability of the sample is significantly increased which results in longer inductive period than that of sample with 0.2% extract.

Similar relations were observed for plant extract 3 (Chenopodium ambrosiodes L.) with added citric acid and lecithin, as shown in Figure 4.

Comparing Figures 2, 3 and 4 it can be seen that the extracts possess the antioxidative activity, that the synergists increase this effect and that even with addition of the synergists, the stability of the sample with 0.01% BHA is not achieved.

Figure 5 shows the effect of Chenopodium ambrosiodes L. extract on the oxidative stability of completely bleached sunflower oil. This substrate shows even lower oxidative stability than lard because the passing of hexane oil solution through the column removes the greatest quantity of substances stabilizing the refined oil. The addition of extract 3 increased the oxidative stability of oil in general for approximately 2 times, while 0.01% of commercial antioxidant BHA increases the inductive period for approximately 4 times. The samples with added synergists, 3C (0.015% extract + 0.005% citric acid) and 3B (0.15% extract + 0.05% lecithin), possess higher oxidative stability in relation to the sample with only 0.15% extract 3A. It can be concluded that BHA shows a lower effect in bleached sunflower oil than in lard. Extract 3 shows also a certain decrease in antioxidative activity in comparison with the application in lard.

REFERENCES


ACTIVIDAD ANTIOXIDATIVA DE EXTRACTOS ETANÓLICOS DE PLANTAS EN MANTECA Y ACEITE DECOLOTADO DE GIRASOL

RESUMEN

Los experimentos llevados a cabo con extractos de plantas con etanol, 1 (Asclepias syriaca L.), 2 (Astragalus onobrychis L.) y (Chenopodium ambrosiodes L.) en manteca y en aceite de girasol decolorado, como sustratos mostró su actividad antioxidativa. El incremento de la concentración de extracto y la adición de ácido cítrico o lecitina como sinérgicos incrementó el periodo inductivo. De la comparación de la actividad oxidativa de la muestra con 0.01% BHA, de la muestra control y de las muestras con adición de extractos investigados puede ser observado que el efecto del extracto incluso a una concentración significativamente alta, es varias veces mas baja que los antioxidantes comerciales. La adición de sinérgicos mejora el efecto del extracto, pero esto no puede cambiar tal relación de actividad antioxidativa. El uso de sustratos significativamente insaturados, decoloró completamente el aceite de girasol, lo que indica para el extracto de plantas número 3, prácticamente el mismo orden del periodo inductivo. El mencionado decremento en diferencias es causado no por un incremento significativo de la actividad antioxidativa del extracto en sí mismo, sino por la actividad mas baja de BHA en sustrato lo que indica la importancia de una adecuada selección de sustrato en las aplicaciones de materiales antioxidativos.
ACTIVITÉ ANTIOXYDANTE D’EXTRAITS À L’ETHANOL DE PLANTES, SUR LA GRAISSE ANIMALE ET L’HUILE DE TOURNESOL RAFFINÉE

RÉSUMÉ

Les expérimentations conduites sur des extraits à l’ethanol de plantes 1 (Asclepias syrtaca L.), 2 (Astragalus onobrychis L.) et (Chenopodium ambrosiodes L.) sur la graisse animale et l’huile de tournesol raffinée comme substrats ont montré leur activité antioxydante. L’augmentation de la concentration d’extrait et l’addition d’acide citrique ou de lécithine comme adjuvants accroissent la période d’induction. La comparaison de la stabilité oxydative de l’échantillon avec 0.01% de BHA, de l’échantillon témoin et des échantillons traités par les extraits étudiés, permet de voir que l’effet de l’extrait, même à une forte concentration (0.2%) est plusieurs fois plus faible que celui des antioxydants commerciaux. L’addition d’adjuvants améliore l’effet de l’extrait, mais ne change pas la relation vis-à-vis de l’activité antioxydante. L’utilisation de substrat fortement insaturé d’huile de tournesol complètement raffinée, donne pratiquement le même niveau de périodes d’induction avec l’extrait de plantes 3. La diminution déjà mentionnée est causée non pas par une augmentation significative de l’activité antioxydante de l’extrait lui même, mais par une plus faible activité du BHA dans le substrat, ce qui traduit l’importance du choix d’un substrat adapté pour l’application de produits antioxydants.