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Oilseed Protein Ingredients as Antioxidant for Meat in Foodservice[1]

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ABSTRACT

This study indicates that glandless cottonseed, peanut or soy protein ingredients may be incorporated in gravy or sauce for precooked meat products to retard development of oxidative rancidity. The oilseed protein ingredients were incorporated in the gravy in which cooked ground beef patties (100% beef) were stored; also, hot-water extracts of the protein ingredients were used as a cover liquid for refrigerated roast beef slices. Oxidative rancidity in the beef patties or in the roast beef slices after 3 and 6 days of storage at 4 C was determined by the thiobarbituric acid test.

Oilseed protein ingredients are used in meat products for their economic, functional and nutritional attributes. A less recognized but very important property of these ingredients is their antioxidative characteristic. Antioxidant effect of soy protein ingredients has been reported in raw ground beef patties (*3,19*), cooked beef loaves (*15*) and vegetable-beef soup (*14*). The nature of antioxidant compounds in soybeans and their products has been investigated rather extensively (*2,6,8,9*). In the studies we conducted recently on the antioxidant property of oilseed protein products, glandless cottonseed and peanut protein ingredients were included along with soy protein ingredients. Antioxidant activity of aqueous and methanolic extracts of the protein ingredients has been studied in various lipid peroxidation model systems (*12,13*), and antioxidant potential of the same ingredients has also been investigated in cooked ground beef patties (*21*).

The objective of the present study was to determine the effectiveness of various oilseed protein ingredients in retarding rancidity development in stored cooked meat products when they are used as an ingredient of gravy or liquid (sauce) for precooked meat products. The oilseed protein ingredients used in the study were defatted flours, concentrates and isolates -- cf. the article by Alden (*1*) for the differences among the three types--prepared from glandless cottonseed, peanut and soybean. The extent of oxidative rancidity development in meat samples was determined by the distillation thiobarbituric acid (TBA) test, as described in "EXPERIMENTAL". The TBA test has been used successfully by many investigators (*4,10,20,22*) to measure lipid peroxidation during short term storage of cooked meats.

EXPERIMENTAL

Oilseed protein ingredients

Soy protein ingredients were commercial products. Glandless cottonseed (McNair variety) and peanut (Spanish variety) protein ingredients were produced on a pilot-plant scale at the Food Protein Research and Development Center, Texas A&M University. Defatted cottonseed flour was prepared by hexane extraction and the isolate, a classical isolate with both storage and non-storage protein included (*5*), by alkali extraction of defatted flour, followed by isoelectric protein precipitation. Peanuts were prepressed to remove a bulk of oil before extraction with hexane for defatted flour; the isolate was prepared by alkali extraction of defatted flour and isoelectric protein precipitation. Both cottonseed and peanut protein concentrates were prepared by acid-water leaching of defatted flours. All these oilseed protein ingredients had been tested previously in our studies on water-soluble (*12*) and methanol-soluble (*13*) antioxidant activities, and on extended beef patties (*21*).

Ground beef patties with gravy

The gravy contained 3% of an oilseed protein ingredient, 1.8% partially hydrogenated shortening, and 0.6% salt. To prepare the gravy, shortening was first melted in a stainless steel frypan, oilseed protein ingredient was blended in and browned, water (distilled, deionized) was added, and the mixture was boiled for 5 min. Liquid lost due to evaporation was replaced after boiling the gravy.

Beef patties (100% beef) were prepared from freshly ground beef (20% fat) purchased from a local supermarket. The ground beef batch used for each set of experiments was thoroughly mixed. Patties, 70-g each, were formed mechanically and cooked to a final internal temperature of 74 C, as described by Ziprin et al. (*21*). A cooked patty (approximately 50 g) and 65 g of gravy were placed in a storage plastic bag and stored at 4 C for 3 or 6 days. As controls, patties stored in gravy with wheat flour replacing oilseed protein ingredient and patties stored in distilled deionized water, were included.

Roast beef slices with cover liquid

A 6% (w/v) aqueous extract was prepared with each oilseed protein ingredient, as described by Rhee et al. (*12*), and used as cover liquid for roast beef slices.

Fresh beef eye round was purchased from a local supermarket. It was trimmed of all visible external fat and roasted in a preheated oven at

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163 C to a final internal temperature of 74 C. The roast was cooled for 20 min and mechanically sliced to a thickness of approximately 3 mm. Three slices were removed from both ends of the roast and brown exterior parts were trimmed from the surfaces of each slice to avoid using the over-cooked portions. Thirty-gram portions of the beef slices were placed in 100-ml beackers and covered with 30 ml each of the aqueous oilseed protein extracts. The beakers were then covered with aluminum foil and stored at 4 C for 3 days.

Rancidity test

The distillation TBA method of Tarladgis et al. (*17*), as modified by Rhee (*11*) to include adding 5 ml of a 0.5% solution of propyl gallate and EDTA for each 10-g sample in the blending process, was used to determine the extent of rancidity development in the cooked ground beef patties and roast beef slices after they were removed from the gravy or cover liquid. The TBA reagent was prepared in distilled water instead of an acidic medium (*18*).

The reason for modification of the distillation TBA method by Rhee (*11*) was that, since the lipid is exposed to heat, light, oxygen and catalysts (such as trace metals, hemoproteins or other iron proteinates) in the distillation TBA test of animal tissues, the test conditions themselves may contribute to the results obtained (*7*); the addition of propyl gallate and EDTA in the blending process was found to minimize further lipid oxidation occurring during the distillation TBA test of animal tissues.

To minimize variations due to sampling or the error of the method with the same sample, the following steps were taken for the TBA test: (*a*) two beef patties for each treatment or the entire 30 g of roast beef slices per treatment were blended with 1.5 times (in milliliters) as much distilled water as the sample weight and half (in milliliters) as much of the propyl gallate-EDTA solution as the sample, and (*b*) 30 g of the slurry (= 10 g of meat sample) were taken for each distillation. The duplicated distillation results of ground beef slurries prepared in this manner showed very little variation between the duplicates (*11*). Each meat sample slurry was, therefore, distilled in one replicate in this study but the TBA color was developed in duplicate with each distillate. Data shown in Fig. 1 and Table 1 are the means of the duplicate color determinations.

RESULTS AND DISCUSSION

Each oilseed protein ingredient incorporated in gravy at a level of 3% retarded rancidity development in the refrigerated ground beef patties covered with the gravy, and no marked and consistent differences were found among the oilseeds in antioxidative effectiveness (Fig. 1). In contrast, cottonseed protein ingredients showed a higher antioxidant potential when the oilseed protein ingredients were incorporated in ground beef to make extended beef patties (*21*). It should be noted, however, that cottonseed concentrate and isolate formed small aggregates when blended with heated shortening and water to prepare gravy. This might have reduced their antioxidative effectiveness.

Aqueous extracts (6% in concentration) of the oilseed protein products were very effective in retarding rancidity development in roast beef slices (Table 1). Regarding the differences among the oilseeds, glandless cottonseed product was somewhat more effective than peanut and soy products within the defatted flours and also within the concentrates. The uniquely poorer performance shown by the extract of peanut concentrate is most likely due to the differences in the beef slices used for the extract. In spite of all the precautions taken to reduce the variability of beef slices (see "EXPERIMENTAL"), there still were sources of variability which

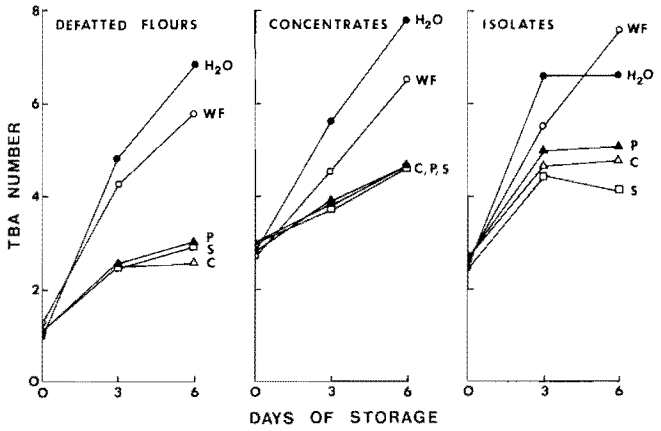

Figure 1. *Lipid peroxidation in ground beef patties (100% beef) covered with gravies containing oilseed protein ingredients. WF - wheat flour; C - cottonseed; P - peanut; S - soybean.*

Table 1. *Lipid peroxidation in roast beef slices covered with aqueous extracts of oilseed protein ingredients and stored for 3 days at 4 C.*

Extract	TBA number
Defatted fours	
H_2O (control)	4.4
Cottonseed	1.3
Peanut	1.5
Soybean	1.7
Concentrates	
H_2O (control)	4.1
Cottonseed	1.0
Peanut	2.9
Soybean	1.5
Isolates	
H_2O (control)	4.6
Cottonseed	2.0
Peanut	1.8
Soybean	1.9

were difficult to control, e.g., the distribution of marbling fat within a large piece of eye round roast.

The TBA values of beef patties or roast beef slices stored without any gravy or liquid, i.e., even without distilled water, were not determined in this study. Comparative studies of rancidity development in meat items with liquid cover vs. no liquid cover will be highly desirable.

Most oilseed products contain considerable amounts of phenolic compounds (*13,16*) and many phenolic compounds are known to be potent antioxidants. The nature of phenolic antioxidants in soybeans and soy protein products has been studied extensively (*6,9*); polyphenolic antioxidants of soy were found to be isoflavones, chlorogenic acid isomers, caffeic acid and ferulic acid. Little study has been done, however, on characterization of antioxidant compounds in glandless cottonseed or peanut.

Lipid peroxidation is a major cause of quality deterioration in meats and meat products. Cooked meats develop oxidative rancidity much more readily than raw meats. Rancidity can develop in cooked meats exposed to

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oxygen and held at room temperature in a few hours, whereas it develops more slowly in cooked meats stored at freezing temperature. Control of lipid peroxidation in meat product has become more important with the greater use of large quantities of precooked meat items by the rapidly increasing fast foodservice facilities and in institutional feeding, and also with the increasing use and demand of frozen convenience food products by the consumer. Precooked frozen convenience meat products have to be reheated before serving. Reheating contributes to further development of rancidity in these products. Many precooked frozen convenience meat products, including T.V. dinners, are packaged and served with sauce or gravy. In cafeterias and other mass feeding facilities, certain meat items, such as steaks, patties and slices of roast, are often maintained in gravy or sauce containing natural meat juice to be served *au juś* and kept warm from the time they are cooked till the end of the serving period, which may amount to more than a few hours. Results of the present study indicate that incorporation of small amounts of compatible oilseed protein ingredients in sauces, gravies and other serving liquids used for precooked meat products may provide the needed antioxidant protection for the products during preparation or processing, handling, storage, reheating and serving.

Before these oilseed protein ingredients can be used as antioxidants for meat in foodservice, studies are needed to evaluate the effect of incorporating them in gravies, sauces and other liquid covers on sensory quality of the meat items concerned, even though the use of 3.3% (as dry product) of the same oilseed protein ingredients in extended ground beef patties did not significantly affect the sensory quality of unseasoned, cooked patties (*21*). Also needed are studies on possible changes in nutritional quality, especially mineral bioavailability, of the meat items as affected by liquid covers containing these oilseed protein ingredients.

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