A C T A   A L I M E N T A R I A   P O L O N I C A
Vol. XIII (XXXVII), No. 2 1987

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YELLOW PEA (*PISUM SATIVUM*) AND ITS PRODUCTS AS A SOURCE OF NATURAL ANTIOXIDANTS. PART II. CHANGES ANTIOXIDANT PROPERTIES OF PEAS DUE TO THERMAL AND MECHANICAL TREATMENT

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Key words: yellow pea, thermal inactivation of antioxidants, mechanical inactivation of antioxidants.

Pea flour was obtained by industrial-scale heating and grinding of yellow peas. The technological treatment caused a decrease by up to 70% of antioxidant properties of pea products used as additives to lard or smoked lard.

INTRODUCTION

In Polish food industry pea is used chiefly in soup concentrate production. These products are highly nutritive [1, 2, 14, 17] and the main reason for their reduced shelf-life are changes in the fat fraction [13, 19]. Preliminary research has shown that pea exhibits strong antioxidant properties [9]. However, before being used in the production of soup concentrates it is subjected to intense thermal and mechanical processing. Elevated temperature may lead to a partial decomposition of endogenous antioxidants or to the appearance of new compounds with antioxidant properties. It is also possible that both processes occur simultaneously and that the conditions of thermal processing have a decisive effect on the antioxidant effectiveness of the finished product. The mechanical processing (grinding and sieving) which is also used in the production of pea flour may lead to the elimination of some of the antioxidants present in the shell or outer pod layer.

Since there are no data in the literature concerning changes of antioxidant properties of pea during industrial processing, we undertook studies of the effect of selected technological processes on the antioxidant activity of this legume.

MATERIAL AND METHODS

The experiments were performed with the Wiktoria pea variety. One batch of peas (denoted Wiktoria I) was treated in industrial conditions according to the technology of pea flour production used in the food concentrate industry. Pea was heated in a rotary heat boiler with a heating jacket; steam pressure in the mantle was either 0.2 MPa (2 atm, 120°C) or 0.4 MPa (4 atm, 140°C). The roasted pea was cooled in a column cooler and then ground in a roller mill. The yield of the grinding process was 92% and the waste products consisted of bran and shells in 1:1 weight ratio.

Another batch of pea (Wiktoria II) was processed into dry mashed peas (pudding) using an industrial technology applied in the potato industry. Pea was steeped for 8 h and then steamed directly with water steam at 0.14 MPa (1.4 atm, 110°C) for 1 h. Next the pea was mashed, its humidity was reduced to about 60% by an addition of dry mashed peas (so called feed-back), and the obtained mass was then dried in a pneumatic drier in an air stream heated to 160°C.

The substrates for studying the antioxidant properties of pea was class-I pork lard and smoked lard (pork lard with 0.025% smoking fumes preparation).

The antioxidant properties of pea and of products of its processing were investigated with the Schaal test at 60°C [12]. Samples equivalent to 20% dry mass of pea were added to the fat in all tests, with the yield of the various technological processes taken into account. The degree of fat decay was established by determining the Lea peroxide number. The experiments were assumed to come to an end when the Lea number in the fat increased to 10. The test results were interpreted with the so called antioxidant effectiveness coefficient (Aec) computed as the ratio of the time by which the applied pea addition extends the period before the fat attains the limit values of the Lea number to the time needed by untreated fat to attain the suitable values of the Lea number.

The raw materials used to produce the model soup mixes were pea flour obtained from pea heated at steam pressure 0.2 MPa or dry mashed peas and lard or smoked lard. The mixes contained 85% of pea products and 15% fat; the fat content is analogous to that in the courrently manufactured pea soup concentrates. The reference sample consisted of model mixes in which the pea products were replaced by potato flour. Before being added to the mixes, potato flour was dried at 40°C till its water content dropped to 9.5%; this was done to keep the humidity of both kinds of mixes at similar levels.

The potato flour-to-fat ratio was determined experimentally to obtain a product with a structure similar to that of concentrates based on pea. The reference mixes contained 88% potato flour and 12% or lard or smoked lard. The fats used in the production of concentrates were melted at 50°C, mixed with the dry components, placed in glass jars and stored in darkness for 18 months at 20 ± 2°C. The initial water content in thus prepared mixes was 8.4 ± 0.7%.

The products were periodically subjected to sensory evaluation by the scale method [15], and in the extracted fat there were determined: the peroxides content [16] and the TBA index by the direct distillation method [18]. The fat for chemical determinations was cold-extracted with chloroform.

RESULTS AND DISCUSSION

The results of the study of natioxidant effectiveness of pea and of its products are presented in Table 1.

Table 1. Antioxidant properties of peas and pea products used as additive to lard or smoked lard — tested during storage at 60°C

Product	Time to obtain the Lea number 10 (hours)		Antioxidant effectiveness coefficient (Aec)	
	lard	smoked lard	lard	smoked lard
Pea Victoria I, raw (not heated)	5278	5421	27.38	1.67
Pea heated at steam pressure of 0,2 MPa (A)	2636	3155	13.17	0.56
Pea flour from "A"	2584	3144	12.89	0.55
Pea heated at steam pressure of 0,4 MPa (B)	2132	2919	10.46	0.44
Pea flour from "B"	2080	2930	10.18	0.44
Pea Victoria II, raw (not heated)	4793	5284	24.77	1.60
Dry mashed peas (pudding)	1466	2992	6.88	0.47
Blank test	186	2029		

A highly significant drop in the pea's ability to retard oxidation processes in lard was found to have been brought about by the legume's technological processing. The heating of pea for 3 h at 0.2 MPa steam pressure in the boiler's heating mantle reduced its antioxidant effectiveness by about 50%; when the steam pressure was 0.4 MPa this drop was about 60%. Mechanical processing (grinding and sieving) of pea heated at either of the steam pressures led to a slight about 1%) but significant reduction of the pea's antioxidant effectiveness. This indicates that a part of the compounds with antioxidant properties or of their synergists are localized in the shell or in the outer pod layer. The greatest drop in antioxidant activity (of about 70%) was observed during steeping and direct steaming (dry mashed peas). Technological processing was also responsible for a drop in antioxidant properties of pea with respect to smoked lard. However, the antioxidant effectiveness of the obtained product did not depend in a significant manner on the method or conditions of the process. The Aec of all the investigated products was about 70% lower than in pea prior to processing.

It is worth noting that smoked lard is highly stable despite the fact that the antioxidant activity of pea and its products was much weaker towards smoked lard than towards ordinary lard. This confirms the previously demonstrated strong antioxidant properties of the smoking fume preparation towards lard [5-8, 11].

Since the products of industrial processing of pea are used primarily in the manufacture of soup concentrate mixes, we studied the effect of pea flour obtained from pea heated at steam pressure 0.2 MPa and of dry mashed pea — i.e. products exhibiting, respectively, the highest and the lowest antioxidant capability with respect to lard in the Schaal test — on the stability of fats in the model mixes during natural storage.

A neutral fat carrier frequently used in studies of antioxidant effectiveness in dry food mixes is carboxymethylcellulose [4, 10] and Bishov [3] alyso found that starch has no effect on the quality and stability of poultry fat. Our own preliminary research demonstrated that potato flour too does not affect oxidation changes in lard, both smoked and unsmoked, in conditions of accelerated axidation at 60°C. In view of the above we prepared for comparison mixes in which pea products were replaced by predried potato flour.

Changes of the concentrates' sensory values during storage are presented in Table 2, and changes of chemical indices in fat are given in Table 3. Pea products extended the shelf life of lard 4.5 times and of smoked lard by over 50%; they also significaltny inhibited the appearance of primary and secondary oxidation products in both fats. On the other hand, during the 18 months of storage there were no great changes in the antioxidant activity of pea flour and dry mashed peas, and this may indicate that the conditions of thermal processing of pea will have no effect on the fat fraction in soup concentrate mixes. Worth noting is that mixes of pea products with lard or smoked lard were of similar quality after 18 months of storage. Till now only very stable fats such as beef tallow or smoked lard were used in soup concentrates production. The results obtained in this research demonstrate thtat it is possible to produce pea soup concentrates based on lard.

Table 2. Changes of sensory values in model blends of dry soup mixes during storage at 20±2°C (in 5-point scale)

Sensory value	Composition of blend	Time of storage (months)									
		0	2	4	6	8	10	12	14	16	18
Taste	A+C	5.0	5.0	2.9	1.5	1.0	1.0	1.0	1.0	1.0	1.0
	A+D	5.0	5.0	5.0	4.9	4.3	3.4	3.9	4.0	3.8	3.4
	A+E	5.0	5.0	4.9	4.8	4.5	3.4	4.0	3.9	3.4	3.2
	B+C	5.0	5.0	4.7	4.3	3.6	3.2	2.8	2.0	1.7	1.5
	B+D	5.0	5.0	4.9	5.0	4.8	4.5	4.3	4.3	4.0	3.6
	B+E	5.0	5.0	5.0	4.8	4.6	4.3	4.1	4.0	3.8	3.3
Flavour	A+C	5.0	5.0	2.8	1.6	1.0	1.0	1.0	1.0	1.0	1.0
	A+D	5.0	5.0	4.7	4.6	4.2	4.0	4.0	3.9	3.7	3.3
	A+E	5.0	5.0	4.9	4.8	4.4	4.2	4.0	3.8	3.6	3.2
	B+C	5.0	5.0	4.8	4.4	3.8	3.5	2.9	2.6	2.0	1.8
	B+D	5.0	5.0	5.0	5.0	4.8	4.5	4.4	4.3	4.0	4.0
	B+E	5.0	5.0	5.0	4.9	4.6	4.5	4.2	4.0	3.9	3.5

A — lard; B — smoked lard; C — predried potato flour; D — pea flour; E — dry mashed peas (pudding)

Table 3. Changes of chemical indices of fat in model blends of dry soup mixes during storage at 20±2°C

Sensory value	Composition of blend	Time of storage (months)									
		0	2	4	6	8	10	12	14	16	18
Lea number	A+C	0.3	1.3	9.2	33.5	46.6	143.1	216.4	314.2	364.6	285.8
	A+D	0.3	0.5	0.8	1.0	1.0	1.2	1.1	0.7	0.6	1.1
	A+E	0.3	0.5	0.6	1.0	1.2	1.3	0.9	0.9	1.3	1.3
	B+C	0.4	1.0	1.8	3.2	4.3	4.0	4.9	6.1	6.3	7.2
	B+D	0.4	0.7	0.4	0.6	0.8	1.2	0.5	0.3	1.1	1.0
	B+E	0.4	0.6	0.3	1.0	1.2	0.8	0.4	0.2	0.5	1.5
TBA value	A+C	0.02	5.41	26.56	33.32	40.40	49.79	45.36	56.37	76.66	47.33
	A+D	0.04	0.20	1.73	1.69	2.59	3.10	3.11	3.05	2.90	1.25
	A+E	0.05	0.04	2.06	1.90	2.73	2.94	3.35	2.90	3.14	1.86
	B+C	0.35	1.70	2.67	3.40	3.01	4.07	4.10	4.28	4.77	4.75
	B+D	0.35	0.04	0.79	1.28	1.18	1.43	1.46	1.50	2.13	1.82
	B+E	0.30	0.33	1.10	0.99	1.56	1.68	1.84	1.65	2.26	2.44

A — lard; B — smoked lard; C — predried potato flour: D — pea flour; E — dry mashed peas (pudding)

CONCLUSIONS

1. Thermal processing of peas reduces their antioxidant capabilities with respect to lard and smoked lard.

2. Technological processes applied in the production of dry mashed peas cause greater losses of the legume's antioxidant activity in lard than

processes used in the production of pea flour. Moreover, the conditions of pea heating have bearing on the antioxidant effectiveness of the obtained product: pea roasted in less drastic temperature conditions has greater antioxidant activity.

3. Processes used in the production of pea flour and of dry mashed peas reduce the antioxidant properties of pea in smoked lard to the same extent.

4. During 18 months pea flour and dry mashed peas clearly inhibit oxidation processes in lard and smoked lard in model soup concentrate mixes to an equal extent; this indicates that the method of heat processing of pea will have no great effect on the stability of pea soup concentrates.

LITERATURA

1. Bartnik J., Brzozowska A., Paprocka M.: Przegl. Gastr., 1976, **31**, (9), 3.
2. Bartnik J., Brzozowska A., Paprocka M.: Przem. Spoż., 1976, **30**, 404.
3. Bishov S. J.: Food Technol., 1967, **21**, 148.
4. Bishov S. J., Henick A. S.: J. Food Sci., 1972, **37**, 875.
5. Chomiak D., Goryń A.: Roczn. Inst. Przem. Mięsnego i Tłuszcz., 1976, **13**, 93.
6. Chomiak D., Goryń A.: Acta Aliment. Polonica 1977, **3**, 223.
7. Daun H., Grabowska J.: Roczn. Techn. i Chemii Żywności 1967, **14**, 109.
8. Daun H., Tilgner D. J.: Acta Aliment. Polonica 1977, **3**, 231.
9. Grześkowiak B., Pazoła Z., Gogolewski M.: Acta Aliment. Polonica 1987, **13** (XXXVII), 1,
10. Kopecky A.: Fette, Seifen, Anstrichmittel 1968, **70**, 439.
11. Olsen C. Z.: Acta Aliment. Polonica 1977, **3**, 313.
12. Pardun H., Kroll E.: Dtsch. Lebensmittel-Rdsch., 1970, **66**, 413.
13. Pazoła Z., Piechanowski J.: Przem. Spoż., 1968, **22**, 449.
14. Piekarska A., Szczygieł A., Szczepańska A.: Żywienie Człowieka 1975, **2**, 189.
15. Pikielna-Baryłko N.: Zarys analizy sensorycznej żywności, WNT, Warszawa 1975, 270.
16. Pluszyński F., Bagdach J.: Metody badania żywności według norm. WPLiS, Warszawa 1967, 602.
17. Rutkowska U., Warantowicz M.: Roczn. PZH 1975, **26**, 439.
18. Tarladgis B. G., Watts B. M., Younathan M. T., Dugan L.: J. Am. Oil Chem Soc., 1960, **37**, 44.
19. Ziombski H., Kwaśniewska I., Chudzikiewicz M.: Roczn. PZH 1971, **22**, 169.

Manuscript received: December, 1985
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GROCH (*PISUM SATIVUM*) I PRODUKTY JEGO PRZEROBU JAKO ŹRÓDŁO NATURALNYCH PRZECIWUTLENIACZY. II.
ZMIANY WŁAŚCIWOŚCI PRZECIWUTLENIAJĄCYCH GROCHU PODCZAS OBRÓBKI TERMICZNEJ I MECHANICZNEJ

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Streszczenie

Groch przerabiano w warunkach przemysłowych na mąkę grochową (prażenie w warniku obrotowym z płaszczem grzejnym w ciągu 3 h przy ciśnieniu pary 0,2 MPa i 0,4 MPa, mielenie) oraz na puree grochowe (moczenie w wodzie w ciągu 8 h, parowanie w parowniku bezpośrednio parą wodną o ciśnieniu 0,14 MPa w ciągu 1 h, zgniatanie, suszenie w suszarni pneumatycznej w strumieniu powietrza o temp. 160°C). Badano efektywność przeciwutleniającą otrzymanych produktów w stosunku do smalcu wieprzowego i smalcu wędzonego (smalec wieprzowy z 0,025% dodatkiem preparatu dymu wędzarniczego) za pomocą testu Schaala w temp. 60°C. Z mąki grochowej lub puree grochowego i smalcu lub smalcu wędzonego przygotowano modelowe mieszanki koncentratów zup. Koncentraty przechowywano w temp. 20±2°C bez dostępu światła w ciągu 18 miesięcy i okresowo oceniano sensorycznie, a w wyekstrahowanym tłuszczu oznaczano poziom nadtlenków i wskaźnik TBA.

Stwierdzono, że obróbka termiczna zmniejsza właściwości przeciwutleniające grochu w stosunku do smalcu i smalcu wędzonego (tabela 1). Procesy technologiczne stosowane podczas produkcji puree grochowego powodują większe zmniejszenie efektywności przeciwutleniającej grochu w stosunku do smalcu, niż procesy stosowane w czasie wytwarzania mąki grochowej, przy czym groch prażony w mniej drastycznych warunkach temperatury wykazuje większą aktywność antyoksydacyjną. Natomiast obydwa badane procesy technologiczne w tym samym stopniu zmniejszają właściwości przeciwutleniające grochu w stosunku do smalcu wędzonego. W ciągu 18 miesięcy mąka grochowa i puree grochowe w tym samym stopniu hamują procesy oksydacyjne tłuszczów w modelowych mieszankach koncentratów zup (tabela 2, 3), co wskazuje, że metoda obróbki cieplnej grochu nie będzie w znacznym stopniu wpływała na trwałość koncentratów zup grochowych.