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THIAMIN AND RIBOFLAVIN CONTENTS IN FRESH AND PRESERVED (FREEZING, CANNING) BROAD BEAN SEEDS*

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Key words: thiamin, riboflavin, broad bean, variety, ripeness stage, raw material, frozen foods, appertized canned foods

The contents of thiamin and riboflavin in fresh, blanched and preserved (frozen and canned) broad bean seeds were determined. Four broad bean cultivars in the same ripeness stage and two cultivars in four different stages of ripeness were investigated.

INTRODUCTION

Leguminous plants are universally regarded as a rich source of carbohydrates, protein, mineral salts, and B vitamins [12-14, 18]. The legumes grown in moderate climate zones include kidney-bean, pea and broad bean. In Poland, unlike in a number of Western European countries, the cultivation of the latter plant is not very widespread.

Studies performed in recent years show that southern Poland offers excellent conditions for growing broad beans to obtain seeds in what is known as milk ripeness [8, 9]. In this stage od ripeness the seeds may be consumed directly after harvesting or else preserved by freezing or packing in hermetic containers [7, 13]. Such preservation is at present widely practiced in England, Belgium, Holland and the FRG, allowing year-round consumption of this legume.

The launching of frozen and canned broad bean production by the Polish food industry justifies broader studies of the nutritive value of the offered final products. In this research we determined contents of riboflavin and thiamin in both fresh and preserved broad been seeds of several cultivars

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and in various stages of ripeness; the seeds were preserved either by freezing or by canning.

MATERIAL AND METHODS

The studies consisted of two stages. First, in 1986-87, we determined the contents of vitamins B_1 and B_2 in four broad bean cultivars used for freezing or canning with seeds of 30% dry mass content. One of the studied cultivars, Windsor Biały, has been grown in Poland for a long time, and of all the locally available cultivars this one is reputed to be the one most suited for preservation [12]. The remaining three cultivars — Comprimo RS, Green Hangdown and Threefoldwhite — were either bred or selected in Holland where they are considered to have very good technological properties. In the second stage of studies (1988-89) we considered only two cultivars with the best agrotechnical and technological properties [7, 9], namely Comprimo RS and Threefoldwhite. In this case too we analysed the content of vitamins B_1 and B_2 but this time in products obtained from seeds harvested in a wider range of dry mass content (25, 30, 35 and 40%). The frozen and canned foods made from seeds with such dry mass contents were marked by good organoleptic properties [7].

The raw material for assessment and preservation was harvested from our own experimental plot. Broad beans were grown a year after manuring the earth; the following doses of mineral fertilizers were used: N—40 kg/ha, P—45 kg/ha, K—125 kg/ha.

Thiamin content was determined by the thiochrome method, and riboflavin content by the fluorescence method. Measurements were performed with a Hitachi model 204 fluorescence spectrophotometer. We analysed the raw material prior to processing, the raw material after blanching, frozen foods after six months of deep-freeze storage, frozen foods stored for six months and then cooked to consumption consistency (with the water-to-brine ratio the same as in the canned preserve), and the appertized canned goods after six months of storage. In the final products we analysed both whole seeds and seed contents (cotyledons).

The raw material was assessed three hours after harvesting the pods and about one hour after shelling. Freezing and appertization, both preceded by blanching, were carried out two-three hours after shelling. Seeds were blanched in water at 96-98°C; the raw material-to-water ratio was 1:5. The duration of blanching required to fully inactivate enzymes differed depending on the degree of seed ripeness and was 2.5, 3.0, 3.5 and 4.0 min.

Freezing was done in a Feutron 3101-01 air washer with forced air flow at-35°C . The time of freezing of broad bean seeds placed on trays in ca 3-cm layers to -20°C was 30 min. Frozen seeds were packed in polyethylene film

(0.05 mm thick) suited for this purpose and stored in a cold room at temperatures around -20°C.

Appertizing was done in an experimental autoclave made in the USA. The material was packed in 0.9 dm^3 jars with twist-off lids in doses of 550 blanched seeds per jar. The pickle was brine with NaCl concentration of 2.5% prepared with tap water of ca 13 °N hardness. The time and temperature conditions of sterilization were as follows:

$$\frac{10{:}(15,\ 17,\ 19,\ 21,\ 23){:}15}{118\text{-}120\ ^{\circ}C}$$

which means that only the time of sterilization proper varied, increasing with the increase of dry mass content in the seeds. In the case of the Threefoldwhite cultivar characterized by the smallest seeds, sterilization lased two minutes less than in all the other cases. Following sterilization and cooling, the preserves were transferred to a dark air-conditioned room where they were stored at about 10°C before being analysed.

RESULTS AND DISCUSSION

Fresh seeds of the Windsor Bialy, Comprimo RS and Green Hangdown cultivars with dry mass contents of 30% contained similar amounts of thiamin: 124-138 μg/100 g fresh matter. The content of this vitamin in the Threefoldwhite seeds was almost twice higher: 252 μg/100 g (Fig. 1).

In the two analysed cultivars in more advanced stages of ripeness characterized by dry mass contents of 24-40% the amounts of thiamin was found to increase considerably (Fig. 2), with Threefoldwhite seeds continuing to stand out as regards vitamin B_1 content. The thiamin level in the youngest seeds was 198 μg in 100 g fresh matter, and in subsequent stages of ripeness the content of this vitamin was higher by 30, 40 and 45% average figures for the two cultivars. In his analysis of canned pea, Morrison [17] found no correlation between seed ripeness and thiamin content.

The studied broad bean cultivars also differed as regards riboflavin content Fig. 1. Green Hangdown was the cultivar with least vitamin B_2 content — 54 μg in 100 g fresh mass. In the remaninig cultivars in the same strage of ripeness this figure ranged from 61 to 66 μg.

Riboflavin was found to decrease considerably as ripeness increased. In Threefoldwhite beans its content decreased starting from 30% dry mass in the seeds (Fig. 2). The ripest seeds contained only 69% of the riboflavin present in the youngest beans.

According to Doesburg et al. [4] and Hermann [6] broad bean seeds in the milk stage of ripeness contain 60-300 μg thiamin and 120-200 μg of riboflavin

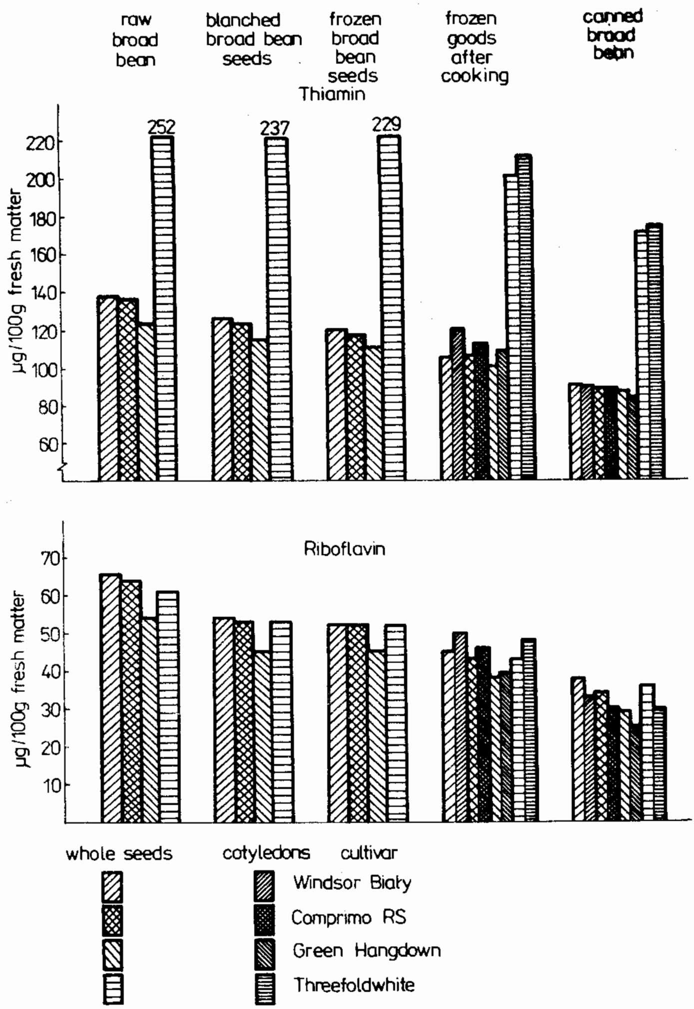

Fig. 1. Thiamin and riboflavin content in fresh and preserved broad bean harvested when their dry mass content was 30%

in 100 g dry mass. Regrettably, these authors do not specify the cultivar they studied and do not give dry mass contents in the seeds. In physiologically mature broad beans there was 440-1500 μg thiamin and 310-440 μg of riboflavin in 100 g fresh matter [14, 18].

Blanching coused losses of both thiamin and riboflavin in raw broad beans (4-10 and 7-18%, respectively). No clear dependence between the magnitude of losses and the cultivar or degree of seed ripeness was observed. The only exception here was the Threefoldwhite cultivar in which the losses were slightly lower, this being perhaps due to the relatively dense structure of its involucre.

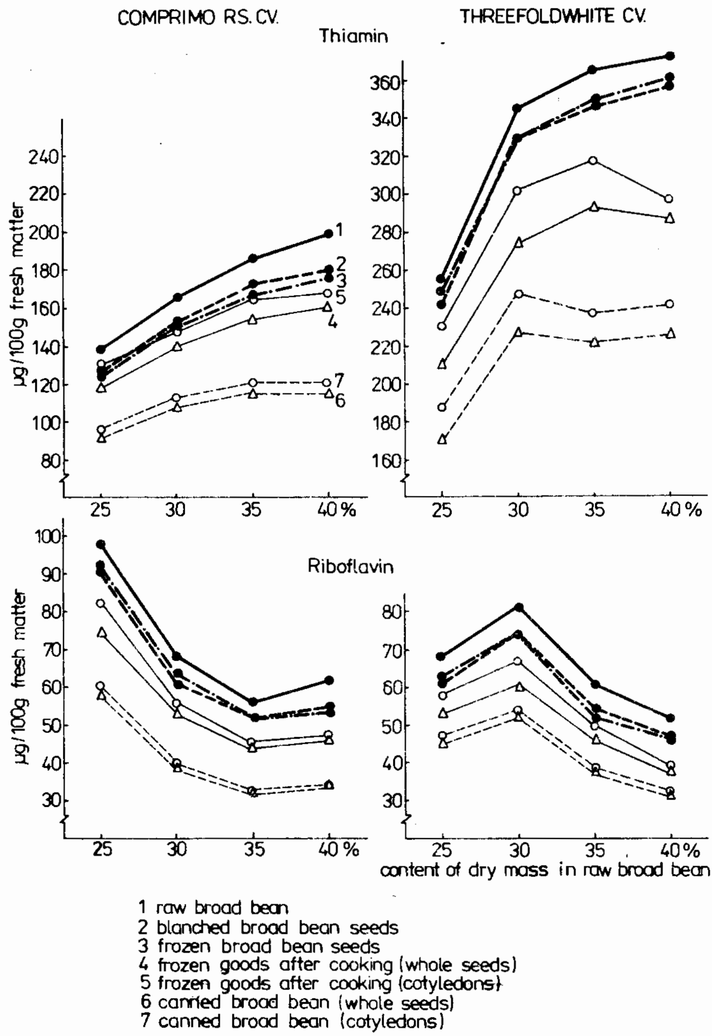

Fig. 2. Thiamin and riboflavin content in fresh and preserved broad bean seeds harvested when their dry mass content was 25, 30, 35 and 40%

Dequidt et al. [3] report large losses of vitamins B_1 and B_2 during processing canning, noting that the magnitude of these losses depend on the kind of vegetable. Also other authors [6, 11] believe that all water treatments, especially in higher temperatures, lead to a drop in the content of these vitamins. However, this opinion is not categorical since Abou-Fadel and Miller [1] demonstrated an increase of thiamin content during blanching of string-beans up to 122% of the content determined in the raw material.

There is agreement in the literature [2, 3, 6, 16] that frozen products preserve thiamin and riboflavin better than canned goods. Compared with the raw material, frozen untreated vegetables contained 85-96% of vitamin B_1 and 79-93% of vitamin B_2, with freezing and deep-freeze storage having practically no effect on these figures. According to Carles [2], frozen pea retained 77% of vitamin B_1; in Morrison [17] the corresponding figure was 90%. Monzini [16] reports that, depending on the species, vitamin B_2 preservation amounted to 84-95%.

The losses of thiamin and riboflavin in frozen products are further aggravated by cooking. Krehl [10] observed that the vitamins behaved differently depending on the manner of cooking. Frozen broad beans were cooked without prior defreezing with a seed-to-brine ratio identical to that used in the canned preserves, which makes possible comparisons of the two products.

Cooking frozen beans reduced vitamin B_1 content by 8-19% and vitamin B_2 content by 13-19% compared with the respective contents in the raw frozen product. Thiamin losses were in general greater in seeds containing more of this vitamin. There was no such dependence in the case of riboflavin. Compared with the raw material, the frozen product prepared for consumption contained 76-85% of thiamin and 68-78% of riboflavin. This means that cooked broad beans contained 100-295 μg of vitamin B_1 and 38-75 μg of vitamin B_2 in 100 g of the product.

Losses caused by sterilization and six-month storage of canned beans, compared with blanched material, amounted to 25-37% in the case of thiamin and 26-40% in the case of riboflavin. The losses increased with the increase of seed ripeness, but despite this the ranking of the various samples as regards vitamin content remained the same as in the raw material. The canned beans contained 86-229μg of thiamin and 29-58 μg of riboflavin in 100 g of product, which means that 57-69% of the thiamin and 53-66% of the riboflavin found in fresh beans was preserved.

Abou-Fadel and Miller [1] found 70% of the thiamin content determined in fresh string-beans in the canned product. In a similar product Lund [15] found only 37% of this content; in canned pea this figure was only 26%, and in both cases the riboflavin content was down to 36%. According to Elkins [5] canned beans contained 42% of the riboflavin found in fresh beans. It is thus likely that the better preservation of vitamins in canned broad beans than in peas or string-beans is due to the thick involucre of the former vegetable.

The cotyledons of cooked frozen broad beans contained 4-15% thiamin and 3-11% riboflavin more than whole seeds. In the case of the canned product, on the other hand, cotyledons contained slightly less thiamin and riboflavin when cultivars were compared, and slightly more of these vitamins when the comparisons concerned ripeness degree.

CONCLUSIONS

1. The compared broad bean cultivars used to produce frozen and canned foods differed as to vitamin B_1 and B_2 contents at 30% dry mass content in seeds.

a. The greatest difference in raw material in thiamin content amounted to 51% (124-252 μg/100 g fresh mass); in cooked frozen and canned beans this figure was 50% in both cases. The cultivar with the decidedly greatest content of this vitamin was Threefoldwhite. Figures in the other cultivars did not differ by more than 10%.

b. As regards riboflavin content, the greatest difference in raw material was 18% (54-66μg/100 g fresh mass), in cooked frozen beans — 15%, and in canned beans — 24%. The greatest quantities of this vitamin were in the Windsor Biały cultivar, and the smallest — in the Hangdown Green cultivar.

2. As the ripeness of the broad bean seeds increased, so did the content of thiamin (in the dry mass range of 25-40%); riboflavin content tended to drop. This regularity was observed both in the raw material and in the final products.

3. Blanching deprived the fresh seeds of 4-10% of their thiamin, and 7-18% of their riboflavin.

4. Freezing nd deep-freeze storage had practically no effect on thiamin and riboflavin contents.

5. Compared with the raw material, cooked whole frozen seeds retained 76-85% of thiamin and 68-78% of riboflavin; in the case of canned beans the figures were 57-69% and 53-66%, respectively.

6. The cotyledons of cooked frozen seeds had slightly more thiamin and riboflavin than analogously processed whole seeds. In canned products this regularity was not observed in all the samples.

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ZAWARTOŚĆ TIAMINY I RYBOFLAWINY W ŚWIEŻYCH ORAZ KONSERWOWANYCH METODĄ MROŻENIA I APERTYZACJI NASIONACH BOBU

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Streszczenie

Ocenie poddano zawartość witamin B_1 i B_2 w następujących odmianach bobu: Windsor Biały, Comprimo RS, Green Hangdown i Threefoldwhite, zbieranych i przerabianych na mrożonki i konserwy przy 30% suchej masy. Ponadto w odmianach Comprimo RS i Threefoldwhite określono zawartość tych witamin w zależności od stopnia dojrzałości nasion w zakresie 25-40% suchej masy, w przedziale co 5%.

Świeże nasiona bobu pozyskiwane przy 30% suchej masy w zależności od odmiany zawierały 124-252 µg tiaminy i 54-66 µg ryboflawiny w 100 g świeżej masy. Zdecydowanie najwięcej tiaminy miały nasiona odmiany Threefoldwhite. Zróżnicowanie między pozostałymi odmianami nie przekroczyło 10%. Wyższą zawartością ryboflawiny charakteryzowała się odmiana Windsor Biały, a najniższą odmiana Green Hangdown. Zróżnicowanie między odmianami w zawartości witamin B_1 i B_2 w produktach finalnych miało podobny charakter jak w surowcu. Wraz ze wzrostem stopnia dojrzałości nasion bobu zawartość tiaminy rosła a ryboflawiny miała tendencję spadkową. Stwierdzenie to dotyczy zarówno surowca, jak i wyrobów gotowych.

Blanszowanie nasion bobu było przyczyną strat tiaminy o 4-10%, zaś ryboflawiny o 7-18% w porównaniu do ilości wykazanej w surowcu. Mrożenie i zamrażalnicze składowanie praktycznie nie powodowało zmian w zawartości tych witamin. Całe nasiona ugotowanych mrożonek w porównaniu z surowcem zachowały 76-85% tiaminy i 68-78% ryboflawiny, a konserw apertyzowanych odpowiednio 57-69% i 53-66%. Liścienie nieznacznie różniły się zawartością badanych witamin od nasion całych.