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Research Article

Effect of Canning Variables on Minerals Content of Bruchid Resistant, Maz-Type Common Bean Lines

Milkesa Feyera*, Demirew Abera

Food Science and Nutrition Research, Melkassa Agricultural Research Center, Adama, Ethiopia

Abstract

Dried beans are rich in proteins and good in important micronutrients like potassium, magnesium, folate, iron and zinc. Canning is a conventional food preserving method in which beans and other products are sterilized by heat after placed in hermetically sealed containers. Screening of bean lines for micronutrient retention during canning is an important input for food industry, beans researcher and other end users. The objectives of this study was to evaluate minerals retention of canned maz-lines common beans. A total of 3 Maz-lines of common beans were evaluated under 9 different canning treatments. Accordingly, mineral contents of maz-type canned common beans were evaluated using atomic absorption spectrophotometer. The result showed maz-type common bean lines and canning variables significantly affects minerals content. The highest calcium (68.79mg/100g) and zinc (2.68mg/100g) were exhibited in Maz-200 common bean lines. Canning variables caused an increment of sodium and calcium contents. However, potassium and zinc contents of canned beans decreased as result of varied canning variables. Good retention of potassium was demonstrated in samples soaked at ambient temperature for 30minutes before blanched at 88 ℃ for 30 minutes. Similarly, good retention of zinc was recorded for sample soaked at room temperature for 40 minutes followed blanched at 75 ℃ for 40 minutes.

Keywords

Blanching, Canning, Minerals, Soaking

1. Introduction

Dried beans are rich in proteins, certain carbohydrates, total and soluble fiber, good in important micronutrients like potassium, magnesium, folate, iron and zinc [10]. It also contains some anti-nutritional compounds that interfere nutrient digestibility and absorption in human body [8]. Those anti-nutritional compounds are considered as bio active components which has a role for preventing coronary heart disease, type II diabetes and obesity. Certain types of common beans have non-nutritive proteins that have insecticidal effects on bean bruchids. Small beetles called bruchids are a common post-harvest pest of stored legumes that can result in significant losses after harvest [15]. Maz-type common beans have been utilized as breeding stock to produce multipurpose common beans because of their exceptional resistance to bruchids. Certain types of beans may be used for both human consumption and income generation. Common beans need to be processed before consumption.

These process changes it's nutritional composition and sensory acceptability. Canning is a conventional food preserving method in which the food product is sterilized by heat

*Corresponding author: milkesafeyera4@gmail.com (Milkesa Feyera)

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after placed in hermetically sealed containers [7]. Dry beans canning quality attributes are influenced by the environment as well as genotype [3]. According to Nyau [11], canned beans are highly demanded due to their ready-to-use nature and extended shelf life.

Canning process includes soaking, blanching and autoclave cooking. Soaking aims to soften and hydration of cotyledon grain that helps to grain uptake 53% to 57% of water content [18]. Blanching is another canning operation which involved as pre-treatment techniques used to avoid oxidation and discoloration of the product by deactivating enzymes and eliminating gasses from the surface and intercellular spaces [20]. Cooking of beans using liquid water, steam water or mixture of two in autoclave take place at temperature ranges between 110 ℃-135 ℃ is a vital canning operation to destruct pathogenic micro -organisms.

These contributes some improvements in nutritional profile, enhance flavors to beans, reduce heat-labile anti-nutrients, and elongate storage life of canned foods. There are maz-type bean lines developed for canning purpose but their micronutrient retention were not known after canning. Additional research on the retention of calcium, iron, sodium, potassium and zinc in canned maz-type common beans line is crucial given to the significance of these minerals in human nutrition. Therefore, the objectives of this study was to evaluate minerals content of maz-type canned common beans.

2. Materials and Methods

2.1. Sample Collection and Preparation

Common beans of MAZ types, a total of 5 lines (Maz- 23, 31,153, 200 and 203) were collected from melkassa agricultural research center and transported to food science and nutrition research laboratory. The sample was cleaned, washed and sorted manually to remove all extraneous materials and broken seeds. The cleaned and sorted seed samples of each bean lines were stored in separate airtight containers until analyzed for their physico chemical and canning attributes.

Table 1. *Treatment combination of an experiment.*

Treatments	Soaking and blanching time in minute	Blanching temperature in ℃	Thermal processing (temperature ℃ *time in minutes)
1	20	60	121*30
2	20	75	121*30
3	20	88	121*30
4	30	60	121*30
5	30	75	121*30
6	30	88	121*30
7	40	60	121*30
8	40	75	121*30
9	40	88	121*30

2.2. Canning Procedure

The cleaned all maz-type common beans were subjected the modified laboratory canning procedure described by [2] for screening based on their canning attributes. About 96 g of Maz- type common beans were weighed in clean plate and transferred to mesh bags. The sample was soaked at room temperature for 30 minutes in distilled water (1:3 gram to milliliter (mL)) and then, blanched for 30 min at 88 ℃ in w ater containing 10mg Ca2+ kg -1 (10 ppm), as calcium chloride dihydrate. After being blanched, the cooled seed sample was taken out from each mesh bag into a bottle cans. Then, the cans were filled with a brine solution, which contained, 1.3% (wt/vol)S o d i u m chloride (NaCl), 1.6% (wt/vol) sugar, and deionized water containing 10 mg $Ca2+\ kg^{-1}$ (10 ppm) as calciumchloridedihydrate. The sealed cans were, processed in a retort autoclave with steam at 121 ℃ for 30 minutes, and then cooled in water at 20 ℃ for 20 minutes. Cans are kept in storage for a minimum of two weeks before the canned product's canning attributes are being evaluated Consequently, three lines with the best canning attributes of Maz-type common beans were selected from 5 Lines based on preliminary screening trial. Then, the selected three maz- lines were

tested under different canning variables as shown in Table 1 following the similar canning procedure mentioned above and evaluated for their minerals composition.

2.3. Minerals

Major minerals such as calcium, iron, zinc, sodium and potassium content of the sample were analyzed by using atomic absorption spectrophotometer according to official method [1].

2.4. Statistical Data Analysis

The collected data was analyzed using SAS Statistical software and subjected to two way analysis of variance (ANOVA). The critical difference at P< 0.05 was estimated and used to find the significant difference. Least significant difference (LSD) test was used to separate the means.

3. Results and Discussions

3.1. Iron

Iron is a crucial micronutrient for the synthesis of hemoglobin. According to Short and Domagalski [17], consuming enough iron in the diet is crucial to lowering the prevalence of iron deficiency anemia. Statistically, variation of maz-lines common beans had a significant influence on the iron content in the present study. As shown in Table 2 the highest and lowest iron content, 10.20, 8.81 mg/100g, were recorded for maz-153 and maz-23, respectively. The current study found that raw maz line common beans had an iron content of 10.05 mg/100g. The highest iron concentration of 10.78 mg/100g was found in canned maz-type common bean lines that were soaked for 20 minutes at room temperature and then blanched for 20 minutes at 60 ℃. The iron content of canned maz-type common bean lines soaked and blanched in water for 30 minutes and above was decreased when compared to raw one. This might be contributed to the leaching of water soluble iron (Fe^{+2}) in blanching water [19].

3.2. Zinc

Zinc is a vital for synthesis of protein and collagen, thus contributing to wound healing and a healthy skin while its deficiency resulted in impaired gastrointestinal and immune functions [6-16]. Considerable variations were noted in the zinc concentration in both maz-type common bean lines and canned beans (Table 2). Canning cause decrement in zinc content from 2.75 mg/100g for raw maz-type common bean lines to 2.10 mg/100g for canned maz-type common bean lines that were blanched for 30 minutes at 60 ℃ after soaked for 30 minutes at room. The current study's finding that the zinc concentration of canned maz-type common bean lines decreased was consistent with that of Pedrosa *et al*., [12], who reported decrement of zinc concentration by 30% for two Spanish common dry beans, canned using industrial canning process.

3.3. Calcium

In the human body, calcium is the most prevalent mineral and is crucial for maintaining bone health [5]. Significant differences (P<0.05) were observed among calcium concentration of maz- type common bean lines. Statistically, the highest (68.79 mg/100g) and lowest (58.66 mg/100g) calcium concentration were noted for Maz-200 and 153, respectively. The result shown in Table 2 revealed that calcium concentration were increased after canning relative to raw maz-type common bean lines. This probable contributed from addition of calcium (Ca^{2+}) to blanching water. The calcium concentration 43.85 mg/100g was recorded for raw maz-type common bean lines followed 70.01mg/100g noted for maz-type bean lines soaked at ambient temperature before blanched at 75 ℃ for 40 minutes.

Table 2. *Effects of main factors (canning variables and Maz-lines) on minerals composition of MAZ-type common beans in mg/100g.*

Maz-lines	Iron	Zinc	Calcium	Sodium	potassium
Maz-23	8.81^{b}	2.19^{b}	65.05^{b}	180.94^{a}	180.21^{a}
Maz-153	10.20^{a}	2.33^{b}	58.66^{c}	158.55^{b}	169.11^{b}
MAZ-200	10.16^{a}	2.68^{a}	68.79^{a}	145.08^{c}	182.87^{a}
CV	7.61	15.03	4.51	1.17	6.15
LSD	0.38	0.19	1.49	0.97	5.64

Treatments	ST and BT in minutes	Blanching temperature in ℃	Iron	Zinc	Calcium	Sodium	potassium
1	20	60	10.78^{a}	2.44^{abc}	65.93^{bc}	153.33^{e}	178.21^{bc}

Treatments	ST and BT in minutes	Blanching temperature in ℃	Iron	Zinc	Calcium	Sodium	potassium
2	20	75	10.17^{ab}	2.39^{bc}	66.22^{bc}	167.66^{c}	169.00^{cde}
3	20	88	9.39^{cde}	2.547^{ab}	67.61^{ab}	154.24^{e}	177.66^{bc}
4	30	60	9.43^{cde}	2.10^{c}	64.37^{cd}	166.00^{cd}	161.03e
5	30	75	9.01^{e}	2.37^{bc}	62.17^{d}	165.58^{d}	172.56^{cd}
6	30	88	9.74^{bcd}	2.20^{c}	64.50^{cd}	132.39^{f}	186.79^{b}
7	40	60	9.89^{bcd}	2.44^{abc}	67.91^{ab}	170.86^{b}	160.83^{e}
8	40	75	9.58^{bcde}	2.57^{ab}	70.01^{a}	172.40^{b}	167.07^{de}
9	40	88	9.20^{de}	2.21^{c}	69.12^{a}	178.23^{a}	162.92^{de}
0	Raw		10.05^{bc}	2.75^{a}	43.85^{e}	154.54^{e}	237.89^{a}
CV		7.61	7.61	15.03	4.51	1.17	6.15
LSD		0.69	0.7	0.34	2.73	1.78	10.29

Note: CV=Coeffient of variation, LSD =Least significant difference, ST= Soaking time, BT= Blanching time, Means within same column followed by the same letters are not significantly different; ($P > 0.05$)

3.4. Sodium

Sodium is an important electrolyte in the human body, that necessary for nerve impulse transmission, muscular function, and metabolic control, among other aspects of physiological homeostasis [4-14]. Sodium concentration of three maz-type common beans and canned samples were presented in Table 2. The maz-type common bean lines showed significant ($P < 0.05$) variation in their sodium content. The result revealed that maz-23 common bean type exhibited the highest (180.94 mg/100g) amount of sodium concentration. Canning treatments caused significant variation for sodium concentration in maz-type common bean lines as presented in Table 2. In the current investigation, samples that were soaked at room temperature for 40 minutes and subsequently blanched at 88 0c for 40 minutes showed the largest rise in sodium (178.23 mg/100g) concentration as a result of canning treatments.

3.5. Potassium

The potassium concentrations of the canned and raw maz-type common bean lines differed significantly ($P < 0.05$), according to statistical analysis. Potassium concentration as a function of canning procedures ranged from 237.89 mg/100g for raw maz-type common bean lines to 160.83 mg/100g for samples blanched at 60 ℃ for 40 minutes after they had been soaked for 40 minutes at ambient temperature as indicated in Table 2. The potassium concentrations in the present study was in consistent with potassium concentration ranged from 81 to 300 mg/100 g reported by Margier *et al*., [9] for pulses frequently consumed in France. This finding showed that the canning methods led to a decrement in potassium concentration. Leaching of the soluble minerals into the soaking and blanching water may be the cause of the decrease in potassium concentration following canning.

4. Conclusions

The results revealed that different canning variables and maz-type common bean lines brought significant influence on some micro-nutrient composition of maz-type common bean samples. Some minerals content of maz-type of canned beans were increased comparative to raw flour. The sodium and calcium contents increased during the canning process. However, as a result of different canning variables, the potassium, iron, and zinc concentrations of canned beans declined. Samples that were soaked for 30 minutes at room temperature and then blanched for 30 minutes at 88 ℃ showed good in potassium retention. Likewise, samples that were soaked for 40 minutes at ambient temperature and then blanched for 40 minutes at 75 ℃ showed good in zinc retention.

Abbreviations

℃	Degree Celsius
ppm	Parts Per Million

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Author Contributions

Milkesa Feyera Tujoo: Conceptualization, Resources, Data curation, Software, Formal Analysis, Supervision, Validation, Investigation, Methodology, Writing – original draft, Writing – review & editing

Demirew Abera: Conceptualization, Resources, Supervision, Validation, Visualization, editing

Conflicts of Interest

The authors declare no conflicts of interest.

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