RESEARCH ARTICLE OPEN ACCESS

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Effect of Retort Processing on The Nutritional Content of Ready-To-Eat Winged Bean Seeds (*Psophocarpus tetragonolobus*)

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ABSTRACT

Winged beans are a source of vegetable protein that has not been optimally utilized. Processing into ready-to-eat foods is an alternative to increasing winged bean consumption. The purpose of this study was to determine the effects of different levels of sterilization (F_0) on the proximate composition of canned winged bean seeds. This study used a randomized block design (RBD) method with three levels of sterilization, F_0 5, 7, and 9. The results showed that different levels of sterilization (F_0 5, 7, and 9) had significant effects ($P<0.05$) on the moisture, carbohydrate, and protein content but had no significant effect ($P>0.05$) on the ash and fat contents of sterilized winged bean seeds. The moisture and carbohydrate content increased as the F_0 value increased. In contrast, the protein levels of sterilized winged bean seeds decreased as the F_0 value increased. Winged bean seeds sterilized with an F_0 value of 9 had the highest levels of moisture and carbohydrates among the other two sterilization levels but had the lowest protein content. The process of canning winged bean seeds using thermal sterilization is an alternative to maintaining the nutritional value of winged bean seeds. However, it still had a minimal effect on the nutritional content of winged bean seeds.

ARTICLE INFORMATION

Submitted: 13/04/2023
Revised: 08/05/2023
Accepted: 19/05/2023
Published Online: 19/05/2023

Keywords:
Proximat compostion
Retort
Sterilization
Winged bean

How to cite this article: Setiawan, R. D., Zakaria, F. R., Sitanggang, A. B., & Ayunda, H. M. (2023). Effect of Retort Processing on The Nutritional Content of Ready-To-Eat Winged Bean Seeds (*Psophocarpus tetragonolobus*). *Journal of Nutrition Science*, *4*(1), 12–16. doi:10.35308/jns.v4i1.7489

Introduction

Winged bean plants grow well in wet tropical areas such as Indonesia, India, Malaysia, Thailand, Sri Lanka, Myanmar, Philippines, and Bangladesh (NAS, 1981). The use of winged beans is extensive, and the part of the plant consumed depends on where the winged bean is cultivated. Young pods are the part most often used for consumption in all regions. The ripe seeds of the winged bean are also commonly consumed, like peanuts, by roasting and boiling (Tanzi et al., 2019). Apart from being a protein source, winged beans contain functional components such as isoflavone factor-2, daidzein, glycitein, and genistein (Wahyuni, 2010). The chemical characteristics of winged bean seeds are influenced by the maturity level of winged bean seeds based on the age at harvest, especially the proximate composition, total phenol content, antioxidant activity, and reducing sugar content (Setiawan et al., 2019).

The amino acid composition of winged bean seeds is similar to that of soybeans. The amino acid composition of winged bean seeds showed that they provided sufficient amounts of essential amino acids and adequate amounts of non-essential amino acids (Wan-Mohtar et al., 2014). The winged bean seed fat in mature seeds was dominated by unsaturated fatty acids (62.3%), monounsaturated fatty acids (33.6%), and polyunsaturated fatty acids (28.7%). The presence of oleic fatty acids (31.7%) and linoleate (26%) are unsaturated fatty acids that are dominant in mature winged bean seeds (Mohanty et al., 2015). (Makeri et al., 2019) stated that winged bean oil is superior to soybean oil because it has high oxidative stability, solid fat content, and good thermal conductivity, which make it suitable for frying food.

The benefits that can be obtained from winged bean seeds are challenging for optimal utilization. Unfortunately, the use of winged bean seeds as an easily consumed food, especially in Indonesia, still needs to be improved. In European and North American markets, peanuts are often processed, cooked, and canned (Schoeninger et al., 2017). Thermal processing is one of the most widely used and safe preservation methods. Inactivation of enzymes and microorganisms is the basis for food preservation using thermal processes. The adequacy of the thermal process to kill the target microbes to the desired level can be evaluated by the process F value obtained from the distribution and penetration test results (Anderson et al., 2011).

Products produced during the retort process have a high level of acceptance. However, thermal processing can still affect the nutritional content and bioactive components of the product (Benjakul et al., 2018). Different sterilization temperatures can be used for materials that are sensitive to heat; therefore, the sterilization process can use temperatures varying from 110°C to 121°C (Heinz & Hautzinger, 2007). The difference in sterilization temperature causes a difference in proximate compostion, texture, color, and sensory reception among consumers (Majumdar et al., 2015). Therefore, this study aimed to determine the effect of differences in the level of sterility using the time (F_0) of the sterilization process in cans on the proximate composition of winged bean seeds.

Method

This study used winged bean seeds obtained from local farmers in Bogor, West Java, with a harvest age of 8 weeks after the first flowering of the plants. This research was conducted at the SEAFAST Center Laboratory, Food Engineering Laboratory, and Biochemistry Laboratory, Department of Food Science and Technology, IPB University.

Research Stages

Preparation of winged bean seed samples

Winged bean seeds were soaked in water (1:3) for 18 h to soften their cellular structure of winged bean seeds and shorten the cooking time at a later stage. The winged bean seeds to be sterilized were filled using a brine solution of sodium chloride (NaCl) with a concentration of 3% and a ratio of 1:2 between the filling solution and the winged bean seeds. The packaging used is can packaging (307 x 111) with a diameter of 87.3 mm and a height of 42.8 mm (United Can, Indonesia).

Process of retorting sterilization

The sterilization process was performed using a retort (Stock Rotozwerg, Italy) at a temperature of 245° F with three target sterilization levels (F_0): 5, 7, and 9. Heat penetration was measured by placing a thermocouple at the center of the package. The products were stacked in one stack in the topmost retort basket, and the retort was completely filled with other cans filled with water. The recorder recorded the change in the temperature of the product in the package to the product every minute. The data resulting from the heat penetration measurements were graphed on a semilogarithmic scale. The temperature is placed on a logarithmic scale (y-axis), while time is on a linear scale (x-axis) (IFTPS, 1992).

The sterility time calculation was obtained from the process sterility value, calculated from the area under the curve on the semi-logarithm. The area under the curve was considered a trapezoid. To calculate the area of the trapezoid, the area under the curve was divided into several parallelograms at certain time intervals. Then, each area was calculated using the formula for the area of the trapezoid so that the lethal rate (LR) and partial sterility (F_0 partial) values were obtained at that time interval. Each partial F_0 is then summed. The results show the total sterility value of the process that has been carried out (Toledo, 2007).

Determination of chemical characteristics of winged bean products

The chemical properties of the canned winged beans were analyzed further. The proximate composition analyzed was moisture content using the oven method (SNI 01-2891, 1992), protein content using the Kjeldahl method (AOAC 955.04 2012), fat content using the Soxhlet extraction method (AOAC 2003.06 2012), ash content using the dry ashing method (SNI 01-2891-1992, 1992), and carbohydrate content using the difference method.

Statistical analysis

This study used a completely randomized design with three levels of sterilization, and all analyses were performed in triplicate. SPSS software (version 16.0; SPSS Inc., USA) was used for statistical data analysis, and the significance of differences between selected parameters was examined using Duncan's multiple range test (DMRT), with a 5% level of probability regarded as statistically significant.

Results

Winged bean seeds were sterilized at 245°F with three F_0 targets: 5, 7, and 9. Commercial sterile food in Indonesia must meet the minimum requirement of having an F_0 value of 3. During the sterilization process, the heat transfer process occurs by conduction in the packaging, which then occurs by a slow convection heat transfer process in the material through a 3% salt solution that acts as a brine solution in the can.

The difference in the F_0 value achieved is due to the difference in the processing time (Pt), which is when the target temperature of 245°F is reached; it is maintained for a predetermined number of minutes. The results show that for F_0 values of 5, 7, and 9, processing times (Pt) of 7, 10, and 14 min, respectively, are required. The proximate composition of winged bean seeds sterilized with various F_0 values is shown in Table 1.

Table 1. Proximate composition of sterilized winged bean seeds at various F_0 values

Proximate Composition (%)	F_0 5	F_0 7	F_0 9
Moisture (wb)	60,34 ± 0,55^a	59,44 ± 0,95^a	62,19 ± 0,35^b
Ash (db)	4,03 ± 1,06^a	4,50 ± 1,47^a	4,80 ± 0,86^a
Fat (db)	9,99 ± 1,98^a	6,64 ± 0,57^a	9,16 ± 2,82^a
Protein (db)	37,81 ± 0,71^b	35,51 ± 2,04^b	34,03 ± 1,05^a
Carbohydrate (db)	49,90 ± 0,39^a	50,93 ± 2,16^a	55,25 ± 1,06^b

Note: Different letters in one column shown a significant difference (P<0.05). Wb = wet basis, db = dry basis

The sample showed a significant difference (P<0.05) between treatments in the analysis of moisture, protein and carbohydrate content, but there was no significant difference (P>0.05) in the parameters of ash and fat content. The moisture content of sterilized winged bean seeds ranged from 59,44 to 62,19%. Statistical analysis showed that the moisture content at sterilization values (F_0) 5 and 7 was not significantly different, but significantly different from the moisture content in the sterilized winged bean seeds at F_0 9. The ash and fat contents in sterilized winged bean seeds ranged from 4.03 to 4.80% and 6.64 to 9.99%, respectively. The lowest protein content was obtained from winged bean seeds that were sterilized at F_0 9 and showed significantly different results from the protein content of winged bean seeds after sterilization at F_0 5 and 7. For the carbohydrate content, F_0 9 also gave the highest value of 55.25% and had a significantly different effect on the other two F_0 values. The carbohydrate contents in F_0 values 5 and 7 showed results that were not significantly different, with values of 49.90 and 50.93%, respectively.

Discussion

The sterilization process using a retort affects the proximate composition of the material being sterilized, and can change during the product storage process (Kumar et al., 2017). Setiawan et al. (2019) also analyzed winged bean seeds aged 8 weeks in raw seeds, which had a nutritional content of 13.01% moisture content, 4.85% ash, 15.40% fat, 38.91% protein, and 40.82% total carbohydrates. Therefore, based on this research, the sterilization process affects the proximate composition of raw winged bean seeds with the sterilized winged seeds, especially on moisture content, fat, protein, and carbohydrates.

The high moisture content in sterilized winged bean seeds is due to the soaking process before sterilization and can increase water absorption in winged bean seeds. The soaking process can increase the moisture content in raw seeds along with longer soaking until a saturation point is reached at a certain soaking time, so that the process of reabsorption of water does not occur (Xu & Chang, 2008). Parmar et al. (2016) also stated that the moisture content of the seeds could increase up to 53-57% due to the soaking process before the cooking process. In addition, the moisture content of sterilized winged bean seeds showed that the higher the F_0 value, the moisture content of winged bean seed will be increase. This is because the higher the F_0 value, the longer the processing time (Pt) required, such that the winged bean seeds experience a longer contact time with the brine solution.

In this study, the results showed that the difference in the value of F_0 did not significantly affect the ash and fat content of canned winged bean seeds. The higher the F_0 value and the longer the sterilization process time did not affect ash and fat content. The same trend was reported by Deol and Bains (2010), differences in cooking methods and time did not affect the ash and fat content of green cowpea (*Vigna unguiculata*). However, compared to raw winged bean seeds, as previously stated above, sterilized winged bean seeds tend to experience a decrease in fat content. The results of this study are in line with those of several previous studies, which reported that thermal processing could reduce the fat content of grains (Aremu et al., 2009, 2010; Audu & Aremu, 2011). Almonga and curruquilla seeds that undergo sterilization processing produce a reduced fat content of up to 16% (Pedrosa et al., 2021).

In the protein content parameter of winged bean seeds, the results showed that the higher the F_0 value, resulting the lower protein content. This was shown in sterilization with an F_0 value of 9, and the winged bean seeds had the lowest protein content compared with the other treatments. Martinez-Ceniceros et al. (2022) also reported similar results, where sterilized pinto beans experienced a decrease in protein levels. On the other hand, Hayat et al. (2014) stated that thermal processing could improve the quality of digestibility and the biological value of protein from grain legumes. This is supported by a report from Sinha et al. (2005), where the cooking process can increase protein digestibility in vitro because it can reduce trypsin inhibitors, which act as anti-nutritional compounds.

The carbohydrate content of the winged bean seeds in this study increased with higher F_0 values. The increase in the carbohydrate content of sterilized winged bean seeds in this study may be related to the loss of soluble solids, especially protein, so it can increase the concentration of the carbohydrate content of winged bean seeds. Loss of protein and other compound components during the sterilization process can be caused by leaching during the soaking and cooking processes (Audu & Aremu, 2011). Regarding nutritional content, winged bean seeds have the same protein and fatty acid profiles as soybean, chickpea, and peanut (Tanzi et al., 2019). In addition, winged bean seeds are included in the legume category, which is a good source of protein, in addition to the benefits of other nutrients in winged bean seeds.

Conclusion

The difference in the level of sterilization (F_0) had a significant effect on moisture, carbohydrates, and protein parameters, but had no significant effect on the ash and fat contents of winged bean seeds. The moisture and carbohydrate contents increased as the F_0 value increased, but decreased the protein content. The soaking and sterilization processes are factors that cause changes in the nutritional content of winged bean seeds caused by soluble solids being dissolved and are affected by the length of soaking time, cooking time, and sterilization temperature. Canning winged bean seeds that are sterilized using various levels of sterilization (F_0) provides an alternative process that can maintain the nutritional value of winged bean seeds. In addition, it is necessary to examine the effect of sterilization using a retort on the bioactive components of winged bean seeds.

Acknowledgement

The author is grateful to LPPM IPB and DIKTI for funding this research through the Program of *Penelitian Terapan Unggulan Perguruan Tinggi* (1658/IT3.11/PN/2018).

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