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Physicochemical Characteristics And Sensory Quality Of Simulated Chips Of Bran-Yellow Pumpkins With Variation Of Drying And Frying Methods

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ABSTRACT

Sources of carbohydrates as a staple food of Indonesian society apart from rice, can also be met from carbohydrates types of tubers and foodstuffs containing starch such as bran and pumpkin fruits. Bran and pumpkin can be processed into flour. Bran and pumpkin can be used as an alternative in the development of food diversification. Substitution of bran flour with wheat flour can be used in the processing of the simulated chips. In the simulated chips processing, the thing that needs attention is the process of drying and frying. The purpose of this study was to determine the physicochemical characteristics and sensory quality of simulated chips with variations in methods of drying and frying. The treatment of frying method consists of deep frying and vaccum frying, while drying method consists of drying by ovens and microwaves. The research design was CRD (completely randomized design) single factor with six replications. The results of this study was the use of a oven microwave drying method using vacuum frying with a low water content (2.69%), protein content and high fat with low-carb content (58.62%). The use of oven microwave drying method and vacuum frying pan could minimize the loss of vitamin E, β-carotene, antioxidants, dietary fiber on the simulated chips and this method is the best method and in term of sensory is acceptable with a score of 5.23 (like to really like).
Keywords: simulated chips, flour, bran, and pumpkin

Introduction

Agricultural commodity in Indonesia is very diverse and depend on the season, so at harvest time availability is abundant. Excess of agricultural products needs to get proper treatment to prolong its shelf life. Excess of production can be overcome by processing in the form of intermediate products such as flour or processing into food products ready for consumption. Flour can be processed from the food that contains a lot of starch, which can be used as an alternative food source of carbohydrate.

Indonesian staple food mostly comes from carbohydrates such as rice. Yet we know the source of carbohydrates other than rice varies, such as tubers and starchy foods, such as bran and pumpkin. Bran is rice mill waste, mostly used as animal feed. Besides, rice bran as a food ingredient has an advantage because it contains antioxidants (Ramezanzadeh *et al*., 1999 and Iqbal *et al*., 2005), dietary fiber, calcium (500-700 mg/100g) and magnesium (600-700 mg/100g), vitamin B complex, vitamin E, essential fatty acids and amino acids (Astawan 2009; Damayanthi *et al*., 2010; and Pasha *et al*., 2002). Pumpkin is a type of vegetables that has a carotenoid composition, pectin, mineral salts, vitamins and other bioactive substances, such as phenolic compounds (Cerniauskiene *et al*., 2014). The yellow color of pumpkin shows the presence of compounds β-carotene (Usmiati *et al*., 2005). With the development of innovation in the world of food, the consumers want more practical presentation of food products, so the bran and pumpkin are potential to be processed into flour (Garayo & Moreira, 2002).

Bran and pumpkin flour can be used as an alternative in the development of food diversification, and its use can be substituted with wheat flour. The second substitution, this flour can be used in simulated chips product. The term simulated chips is used for crisps product that are made from one or more types of flour and made into dough (Matz, 1984). Processing of chips in batter shape allows the use of raw materials that have high

nutritional value, containing dietary fiber, and antioxidants to produce a healthy snack. Important process in processing simulated chips is drying and frying simulated chips.

Drying of simulated chips can extend the shelf life for the dry product has a low water content. One type of commonly used drying method is a oven drying, but the use of temperature for long periods can damage the nutritional content of products. One alternative method of drying to prevent loss of nutrients in dry food is the oven microwaves drying method, this method works by passing microwave radiation on the water molecules, fat and sugar found in food, so that the time required for drying foodstuffs becomes shorter (George *et al*., 1993).

Frying process is a continuation of the drying process. Frying process of simulated chips aims to produce simulated chips that has a savory taste and crisp. The commonly used frying method is a use of frying pan with hot oil (deep fat frying/DFF). This method uses high temperature, ie 163-196^{o}C. The use of high temperatures on this method can cause a loss of some nutrient content of simulated chips. Another alternative that can be used to minimize the loss of nutrients, antioxidants and dietary fiber is simulated chips frying using low temperature under vacuum pressure (vacuum frying/VF) resulting in a more crisp chips. The purpose of this study is to determine the physicochemical characteristics and sensory quality of simulated chips of bran-pumpkins with a variety of methods of drying and frying.

Material and methods

Rice bran and pumpkin are the main ingredient in the processing of the simulated chips. Additional materials used consist of flour, green beans, onions, garlic, salt, refined sugar, baking powder, and margarine. The bran are obtained from Tabanan, while the pumpkins from Badung regency, Bali. The equipment used is an oven (Shel Lab-USA brand, type: 1370 FX), oven microwave of Kris brand with specification: 230V-50Hz, 1400W with a frequency of 2450 MHz, and Geneys 10S UV-VIS spectrophotometer.

This research was conducted from July to December 2013. The processing of simulated chips was done at the laboratory of the Institute for Agricultural Technology (BPTP) Bali, while chemical analysis conducted at Food Laboratory of Agricultural Technology, University of Udayana, the Center for Postharvest Testing Laboratory of Bogor, and the Laboratory of Food and Nutrition Faculty of Agricultural Technology of UGM (Gajah Mada University)

The bran is derived from Cigeulis rice varieties. Drying of rice bran used oven microwave (OM) on the power of 200 watts for 15 minutes. The pumpkins originated from the species of *Cucurbita moschata* (yellow or red pumpkins), dried using OM to the power of 300 watts for 4 hours

The simulated chips processing was done by mixing all the ingredients into a dough that can be formed. Subsequently thin sheets and molded round were made. The treatment method of drying comprises two methods, namely the oven drying and oven microwave. The treatment of frying method consists of deep fat frying and vaccum frying. Treatment of the simulated chips drying used an oven at a temperature of 55°C for 2 hours 25 minutes, while drying using OM in power 30% for 1 hour 40 minutes. Treatment of deep fat frying method (DFF) is at a temperature of 190^{o}C for 18 seconds and the treatment of vacuum frying method (VF) at a vacuum temperature of 80-85^{o}C with frying temperature of 91-92^{o}C for 25 minutes. The design used in this study is the CRD (completely randomized design) single factor repeated six times for each treatment.

Proximate analysis was conducted on water content and ash content using the oven method (Apriyanto, 1989), protein content using the Micro-Kjeldahl (Apriyanto, 1989), fat content using Soxhlet (Apriyanto, 1989), and the carbohydrate content using *carbohydrate by difference* (Apriyantono , 1989). Analysis of dietary fiber content used the Multienzyme (Asp *et al*, 1983). Analysis of the levels of vitamin E using HPLC method. The antioxidant capacity test used DPPH (Blois, 1985). Sensory test used is the favorite test (hedonic) and ranking test using Soekarto's method (1995). The hedonic test was performed using 40 semi-trained panelists to assess the parameters of color, aroma, texture, taste, and overall acceptance of simulated chips. Assessment scores used in the hedonic test was 6 levels, ie 1 = strongly dislike, 2 = dislike, 3 = somewhat dislike, 4 = somewhat like, 5 = like, and 6 = strongly like. Ranking test used to determine the most favored treatment, rank 1 indicated the most preferred product.

The data were analyzed by analysis of variance (ANOVA) using SPSS 16.0. Results of analysis of variance were significantly different ($p < 0.05$) followed by a further test of Duncan's multiple range test (DMRT).

Results and discussion

Results of analysis of treatment variance of simulated chips drying and frying methods had a significant effect ($p<0.05$) against moisture, protein, fat, and carbohydrates but not significant ($p>0.05$) on ash content. The water content and highest protein of simulated crisps contained in POV treatment, respectively by 2.69% and 11.84% (Table 1).

Table 1. Effect of drying and frying method against moisture, ash, and protein of simulated chips

Treatment	Water content (%)	Ash content (%)	Protein content (%)
POD	5.40 ± 0.72 c	5.16 ± 0.00 a	10.87 ± 0.07b
PMD	4.88 ± 0.27 b	5.17 ± 0.01 a	10.16 ± 0.55a
POV	2.71 ± 0.19 a	5.79 ± 1.03 a	11.71 ± 0.14c
PMV	2.69 ± 0.24 a	5.44 ± 0.52 a	11.84 ± 0.63c
LSD (%)	10.64	10.66	3.79

- Figures followed by the same letter in each column showed no significant difference in the level of 5% Duncan test

- Treatment: POD = oven method drying, DFF frying; PMD = OM method drying, DFF frying; POV = oven method drying,, VF frying; and PMV = OM method drying, VF frying

Water content of PMV treatment is lower than POD, it is suspected to be due to frying temperature is under vacuum condition (91-92^{o}C), where the boiling point under vacuum condition with a longer frying time resulted in high water evaporation (Debnath *et al*., 2003). Elevated levels of protein in the treatment of POV and PMV is allegedly because of the method of OM drying and vacuum frying that can prevent protein denaturation due to heat generated in the process of drying and frying (Table 1).

The average highest fat content of simulated chips was found on PMV treatment, amounting to 21.41% and the lowest for the treatment of PMD (15.16%). Increased fat level of simulated crisps on the method of vacuum frying was caused by the fact that a vacuum frying process requires a longer time (25 minutes) compared to frying method DFF (21 seconds), so that more oil is absorbed into the chips (Table 2).

Carbohydrate level is the largest constituent in the simulated chips. On the average, the highest carbohydrate content is in the treatment of PMD (64.63%) significantly different from POD, POV, and PMV, while the POV treatment was not significantly different from PMV (Table 2).

Table 2. The influence of drying and frying methods on the levels of fat and carbohydrate of simulated chips

Treatment	Fat Content (%)	Carbohydrate Content (%)
POD	16.05 ± 0.46 a	62.52 ± 1.06 b
PMD	15.16 ± 0.56 a	64.63 ± 1.04 c
POV	20.46 ± 0.75 b	59.33 ± 1.27 a
PMV	21.41 ±1.85 b	58.62 ± 1.65 a
LSD (%)	5.80	2.09

- Figures followed by the same letter in each column showed no significant difference in the level of 5% Duncan test

- Treatment: POD = oven method drying, DFF frying; PMD = OM method drying, DFF frying; POV = oven method drying,, VF frying; and PMV = OM method drying, VF frying

Results of variance analysis of treatment method of drying and frying had significant effect ($p<0.05$) on the levels of vitamin E and β-carotene of simulated chips. Vacuum drying method significantly increases the amount of vitamin E and β-carotene of simulated chips, respectively of 1.93 mg/100g and 3.29 ug/g (Table 3). This is due to the lower vacuum frying temperature (80-85^{o}C) than DFF frying method (163-196^{o}C).

Tabel 3. The influence of drying and frying methods on the levels of vitamin E and β-carotene of simulated chips

Treatment	Vitamin E (mg/100g)	β-karoten (µg/g)
POD	0.57 ± 0.02 a	2.63 ± 26.68 a
PMD	1.06 ± 0.04 b	2.81 ± 9.24 a
POV	1.17 ± 0.28 b	2.70 ± 12.95 a
PMV	1.93 ± 0.11 c	3.29 ±12.03 b
LSD (%)	12.59	5.83

- Figures followed by the same letter in each column showed no significant difference in the level of 5% Duncan test

- Treatment: POD = oven method drying, DFF frying; PMD = OM method drying, DFF frying; POV = oven method drying,, VF frying; and PMV = OM method drying, VF frying

Results of analysis of treatment variance of drying and frying methods of simulated chips show significant effect ($p<0.05$) on antioxidant capacity, and IC 50. The highest antioxidant capacity was in PMV treatment, amounting to 844.40 ppm GAEAC with IC 50 values of 109.57 mg/ml (Table 4).

Table 4. The influence of drying and frying methods on antioxidant capacity, IC50, and the yield of simulated chips

Treatment	Antioxidant capacity (ppm GAEAC)	IC 50 (mg/ml)
POD	669.39 ± 41.59 a	135.20 ± 9.70 b
PMD	694.09 ± 55.65 ab	181.96 ± 10.19 c
POV	744.07 ± 16.75 b	117.59 ± 8.05 a
PMV	844.40 ± 45.20 c	109.57 ± 3.33 a
LSD (%)	5.77	6.08

- Figures followed by the same letter in each column showed no significant difference in the level of 5% Duncan test

- Treatment: POD = oven method drying, DFF frying; PMD = OM method drying, DFF frying; POV= oven method drying,, VF frying; and PMV = OM method drying, VF frying

The use of a OM drying method using VF fryer had the highest level of vitamin E, β-carotene, and antioxidant capacity. This is presumably due to the use of low temperature under vacuum condition can prevent the destruction of tocopherol by derivatives of fatty acids that are formed during heating and oxidation process

(Palupi *et al*., 2007) and can prevent the loss of the content of antioxidants such as tocopherols, vitamin C, carotenoids, and type of phenol (Shofian *et al*., 2011). While the IC 50 value is inversely proportional to antioxidant capacity, where the higher the antioxidant capacity the smaller the IC 50 value. The IC 50 value in the treatment of PMV, amounting to 109.57 mg/mL was included in the moderate level of antioxidant activity (Ariyanto, 2006).

Results of treatment variance analysis of drying and frying methods of simulated chips showed significant differences ($p<0.05$) toward the content of the IDF, SDF and TDF (Table 5). PMV treatment can minimize the loss of dietary fiber (IDF, SDF and TDF), it is suspected because of the use of low temperature with a pressure below 1 atm is able to inhibit the degradation of processing (Margarita *et al*., 2011).

Table 5. The influence of drying and frying methods on the level of the IDF, MDF, and TDF of simulated chips

Treatment	IDF (% db)	SDF (% db)	TDF (% db)
POD	6.72 ± 0.39 a	4.00 ± 0.26 a	10.72 ± 0.42 a
PMD	8.54 ± 0.70 b	5.54 ± 0.41 b	14.07 ± 0.64 b
POV	12.77 ± 0.98 c	7.60 ± 0.44 c	20.37 ± 1.11 c
PMV	15.55 ± 1.25 d	10.08 ± 0.65 d	25.63 ± 0.87 d
LSD (%)	8.14	6.78	4.52

- Figures followed by the same letter in each column showed no significant difference in the level of 5% Duncan test

- Treatment: POD = oven method drying, DFF frying; PMD = OM method drying, DFF frying; POV = oven method drying,, VF frying; and PMV = OM method drying, VF frying

Results of treatment variance analysis of drying and frying methods had significant effect ($p<0.05$) on sensory test of color, texture, taste, and overall acceptance, but not significantly different ($p>0.05$) on simulated chips aroma. The average value of panelist reception on the simulated chips color is between 3.92 to 4.53 (rather like to like). The highest score of the color attributes contained in the treatment of PMV drying method amounting to 4.53. The panelist acceptance against simulated chips texture in POV and PMV treatments with a score of 4.80 to 4.83 (rather like to like) more preferable by panelists compared with the treatment of POD and PMD. While the highest score of the panelists ratings on the overall acceptance contained in PMV treatment, with a score of 5.23 (like to really like), are presented in Table 6.

Table 6. The influence of drying and frying methods on sensory test of simulated chips

Treatment	Color	Aroma	Texture	Taste	Overall
POD	4.18 ± 0.90 ab	4.55 ± 0.78 a	4.20 ± 0.91 a	3.90 ± 0.74 a	4.12 ± 0.85 a
PMD	3.92 ± 0.94 a	4.45 ± 0.78 a	4.23 ± 0.97 a	4.05 ± 0.93 a	4.20 ± 0.75 a
POV	4.50 ± 0.84 b	4.37 ± 1.03 a	4.80 ± 0.93 b	5.08 ± 0.85 b	5.02 ± 0.66 b
PMV	4.53 ± 1.17 b	4.58 ± 1.10 a	4.83 ± 0.90 b	5.38 ± 0.84 b	5.23 ± 0.80 b
LSD (%)	22.76	20.88	20.66	18.45	16.60

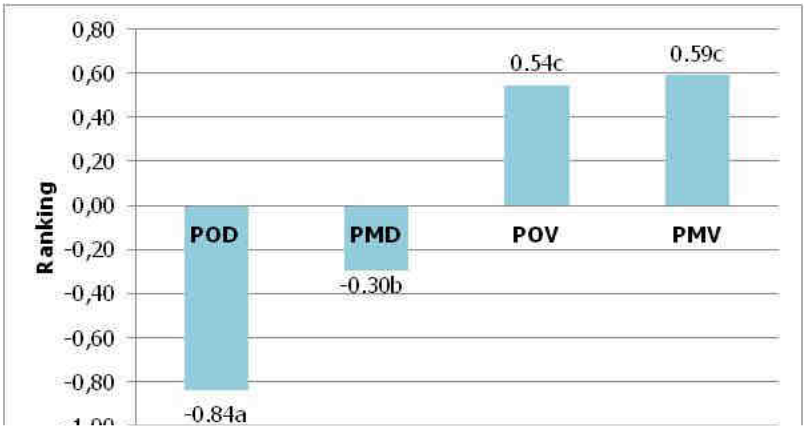
- Figures followed by the same letter in each column showed no significant difference in the level of 5% Duncan test

- Treatment: POD = oven method drying, DFF frying; PMD = OM method drying, DFF frying; POV = oven method drying,, VF frying; and PMV = OM method drying, VF frying

The treatment of using heat in the drying and frying methods can affect the reception of panelists sensory, affecting the color, texture, taste, and overall acceptance of simulated chips. The use of VF frying method can prevent color changes in the product due to the use of high temperature (Garayo and Moreira, 2002 dan Oliveira *et al*., 2016) and improve the texture of simulated chips to become more crisp than the DFF frying method.

Besides, the presence of dietary fiber can improve the texture and improve the stability of the food during processing and storage (Thebaudin *et al*., 1997), so that the chips had a crisp texture/crunchy.

Results of analysis of treatment variance of drying and frying methods showed significant difference ($p<0.05$) to test ranking. Treatment of PMV gets first rank, the 2nd ranking contained in the POV treatment, while 3rd and 4th ranking respectively contained in PMD and POD treatments (Figure 1).



POD Treatment = oven method drying, DFF frying; PMD = OM method drying, DFF frying; POV = oven method drying,, VF frying; and PMV = OM method drying, VF frying

Figure 1.
Ranking test chart of simulated chips on the treatment of drying and frying method

Decision-making to determine the best method is by using Effectiveness Index. The best alternative is to compare the value of chemical analysis and sensory test, by looking at a value corresponding to expectations or research purposes (Figure 2). Effectiveness Index of analysis results of the chemical analysis and sensory test on simulated chips with PMV treatment has a value of TNP, by 0.73 and sensory test value of 1.00 (Table 7) and this is the best treatment.

Figure 2.
The best simulated chips on the treatment of drying oven microwave and Vacuum frying method

Table 7. The best result of simulated chips using the treatment of different drying and frying methods

Treatnent	TNP	
	Chemical analysis	Sensory test
POD	0.27	0.27
PMD	0.37	0.12
POV	0.58	0.71
PMV	0.73	1.00

- *TNP = the total value of the product*
- *Treatment: POD = oven method drying, DFF frying; PMD = OM method drying, DFF frying; POV = oven method drying,, VF frying; and PMV = OM method drying, VF frying*

Conclusion

Differences in methods of drying and frying influence the nutrient content of simulated chips. Oven microwave drying method with a vaccum frying has a low water content (2.69%), protein content and high fat low-carb content (58.62%). The use of the oven microwave drying method and vaccum frying can minimize the loss of vitamin E, β-carotene, antioxidants and dietary fiber in simulated chips. Oven microwave drying and vaccum frying methods are the best methods and in terms of sensory acceptable with a score of 5.23 (like to really like)

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REFERENCE

Ariyanto, R. 2006. Aktivitas Penentuan Kandungan fenolik dan flavonoid Total Fraksi Kloroform dan Fraksi Air Ekstrak Metanolik Pegagan (Camelia astalia L.urban). Skripsi. Fakultas Farmasi. Univ. Gajah Mada.

Apriyantono, A., D. Fardiaz, N.L. Puspitasari, Sedarnawati, dan S. Budiyanto. 1989. *Petunjuk Laboratorium Analisis Pangan*. Bogor : IPB.

Asp, N., G. Johansson, Halmer, and Siljestrom. 1983. Rapid Enzimatic Assay of Insoluble and Soluble Dietary Fiber. *Journal Agritech of Food Chemistry*, 31: 476-482.

Astawan, M. 2009. Bekatul Gizinya Kaya Betul. Diakses dari : http://www.kompas.com. Tanggal : 19 Pebruari 2012.

Blois, M.S. 1958. *Antioxidant Determination by the Use of Electron Free Radical*. *Nature*, 8: 1199-1200.

Cerniauskiene, J., J. Kulaitiene., H. Danilcenko., E. Jariene, dan E. Juknevičiene. 2014. Pumpkin fruit flour as a source for food enrichment in dietary fiber. Not Bot Horti Agrobo.42(1):19-23.

Debnath, S., Bhat, K.K, dan Rastogi, N.K. 2003. Effect of pre-drying on kinetics of moisture loss and oil uptake during deep fat fying of chickpea flour-based snack food. Elsevier Science Ltd. doi:10.1016/S0023-6438(02)00186-X.

Damayanthi, E., L. Kustiyah., M. Khalid., dan H. Farizal. 2010. Aktivitas Antioksidan Bekatul Lebih Tinggi Daripada Jus Tomat Dan Penurunan Aktivitas Antioksidan Serum Setelah Intervensi Minuman Kaya Antioksidan. *Jurnal Gizi dan Pangan*, 5(3): 205-210.

George, R.M. Burnett, dan P.S. Richardson. 1993. *Microwave* Radiation. *Journal of Food Processing*, 3: 26-30.

Garayo, J., & Moreira, R. (2002). Vacuum frying of potato chips. *Journal of Food Engineering*, *55*(2), 181–191. http://doi.org/10.1016/S0260-8774(02)00062-6.

Iqbal, S. M.I. Bhanger and F. Anwar. 2005. Antioxidant Properties and Components of Some Commercially Available Varietas of Rice in Pakistan. Food Chem. 93:265-272.

Matz, S.A. 1984. *Snack Food and Technology*. The AVI Publishing Company, Wesport, Connecticut.

Margarita, C., D.G. Espinosa-Arbelaez, R. Suarez-vargas, and M.E. Rodriguez-Garcia. 2011. Effect of Drying Process on the Physicochemical Properties of Nopal Cladodes of Different Maturity Stages. Plant Foods Hum. Nutr.59(1).DOI:10.1007/s11130-011-0265-x.

Oliveira, D.A.S.B.de., Minozzo, M.G., Licodiedoff, S. dan Waszczynskyj. 2016. Physicochemical and sensory characterization of refined and deodorized tuna (Thunnus albacares) by-product oil obtained by enzymatic hydrolysis. Elsevier Ltd. http://dx.doi.org/10.1016/j.foodchem.

Pasha, I., M.S. Butt, F.M. Anjum, dan N. Shahzadi. 2002. Effect of Dietetic Sweeteners an the Quality of Cookies. Int. J. Agric. Biol. 4(2). 245-248.

Palupi, N.S., F.R. zakaria, dan E. Prangdimurti. 2007. Pengaruh Pengolahan terhadap Nilai Gizi Pangan. Modul *e-Learning* ENBP. Dep. Ilmu dan Tek. Pang. IPB.

Ramezanzadeh, F,M., R.M. Rao, M. Windhauser, W. Prinyawiwatkul, dan W.E. Marshall. 1999. Preventation of Oxidative Rancidity in Rice Bran During Storage. Lousiana State University.

Soekarto, S. T. 1995. *Penilaian Organoleptik untuk Industri Pangan dan Hasil Pertanian*. Jakarta : Penerbit Bharata Karya Aksara.

Sopian, A., R. Thahir, dan T.R. Muchtadi. 2011. Pengaruh Penggorengan Dengan *Far Infrared Dryer*, Oven Vakum dan Freeze Dryer Terhadap Warna, Kadar Total Karoten, Beta Karoten dan Vitamin C pada Daun Bayam (Amaranthus tricolorL.). J. Tek. Dan Inds. Pang. 16(2):133-141.

Thebaudin, J.Y., A.C. Lafebvre, M. Harington, dan C.M. Bourgeois. 1997. Dietary Fibers: Nutritional and Technological Interest. Trend Food Sci. Tech.8:41-48.

Usmiati, S., D. Setyaningsih., E.Y. Purwani., S. Yuliani, dan Maria O.G. 2005. Karakteristik serbuk labu kuning (*Cucurbita moschata*). J. Tek. Dan Ind. Pang.16(2):157-167.