ISSN No:-2456-2165

The Change of Rice Bran Nutritional Composisition using Microwave Heating and Vacuum Packaging during Storage

I W. S. Yasa, A. Prarudiyanto and E. Basuki
Faculty of Food Technology and Agroindustry,
University of Mataram, Indonesia

Abstract:- Deterioration of the crude oil in rice bran by lipase was very fast and, to a smaller extent, oxidase occurs and makes the bran unsuitable for food or feed. Microwave heating offers saving in time, energy, and has a little effect on the nutritional value but if it use to stabilize rice bran, may affect on rice bran functionality. The aim of this research was to find out the alteration of nutritional composition of the stabilized rice bran with microwave heating and vacuum packaging stored for 12 weeks at ambient temperature. Completely Randomized Design with Honestly Significant Different at five percent significant level were applied to combine of microwave heating (with and without microwave), packaging (with and without vacuum) and the length of storage for 2, 4, 6, 8, 10 and 12 weeks at ambient temperature. The proximate and crude fibers of bran were measured for nutritional composition, and free fatty acid content for deterioration indicator of bran. Data was performed with ANOVA and continued with HSD at five percent significant level. The interaction between microwave heating, packaging and the length of storage had no effect on total carbohydrate, ash and lipid content of the bran in contrast to the moisture and protein content. The longer the storage time indicate that the higher the moisture content but the lower of the protein content. Microwave heating had significant effect on minimizing the increase of free fatty acid of the bran during storage and reducing crude fiber significantly.

Keywords:- *microwave, packaging, rice bran, storage.*

I. INTRODUCTION

Each year, five million tons rice bran is produced in Indonesia [6]. Deterioration of the crude oil in rice bran by lipase was very fast and, to a smaller extent, oxidase occurs and makes the bran unsuitable for food or feed. Deactivation method is use as a appropriate technique to resolve this main problem. All the components that bring about the deterioration should be separated or inactivated to process bran into a food or feed grade product of good keeping the quality and high industrial standard.

Several studies have been conducted on stabilization techniques of rice bran and its oil recently [17;15]. Although a number of studies like ohmic heating, dry or moist heat treatment and little bit on pH lowering have been controlled for rice bran and its oil stabilization [4]. However, treatments with microwave heating have not been correctly.

Stabilization can be achieved properly; every separate bran particle must have good moisture content, it depends on the time and temperature of the treatment. Agglomeration of bran is due to moist heat, leads to in lumpy bran. Bran stabilization by extrusion has been produced to be effective but needs large capital investment.

Microwave heating offers saving in time, energy, and has a little effect on the nutritional value [9;10;16;20;18;22]. However if it uses to stabilize rice bran, may influence on rice bran functionality [12]. The rice bran chemical composition is played vital role on the functional properties of rice bran and contributes on nutritional composition of the bran. However, oxidative rancidity by lipoxygenase should enlarge in the presence of oxygen and the rate of hydrolytic and oxidative rancidity should be raise with prolonged storage time. On the other hand, in published literatures that lipase and lipoxygenase are bring into being to be more active for bran samples stored under vacuum [7].

The aims of this study was to indicate the change of nutritional composition of the stabilized rice bran with microwave heating and vacuum packaging stored for 12 weeks on ambient temperature.

II. MATERIALS AND METHODS

Freshly milled rice bran powder samples (from rice variety of IR-64) were collected from a local rice mills situated in areas of Pringgarata Village of Central Lombok Regency.

The experiment was conducted in Food Biochemistry Laboratory, University of Mataram, Indonesia with Completely Randomized Design of factorial with triplicate. Data was performed with ANOVA at five percent of significant level and continued with Honestly Sigificant Difference (HSD) [23].

A. Sample preparation

The fresh rice was milled using a rice milling machine (Satake) at Rice Milling Unit in Pringgarata in Distict of Central of Lombok. Then, milled rice bran was screened to move across a 80 Mesh aperture sieve to eliminate the broken grains, hull fragments, paddy kernels and foreign materials. The rice bran had been kept in sealed PE plastic bags and held in refrigerator at 0 °C in order to maintain the

ISSN No:-2456-2165

increase of free fatty acid (FFA) in the rice bran [20,21,22]. Before heating procedure applied, the moisture content of raw rice bran was adjusted from an original value into a 21 % with the addition of water [12]. The sample was then mixed thoroughly to ensure the water was evenly homogenates.

B. Microwave Stabilization

A commercial microwave oven (Electrolux, Indonesia.) was used as the microwave energy source with operating condition at 2,450 MHz and 550 W maximum output power. The oven was preheated for 3 min before loading the rice bran. One-hundred-fifty grams of raw rice bran that contain 21% moisture content was then placed in a polyethylene microwave-safe bowl and exposed to microwave heating for 3 min at 107 ºC. The bran was then took off from the oven and cooled to room temperature (24ºC). This process was repeated until adequate microwave-stabilized rice bran was prepared for the study.

C. Packaging and Storage

Samples of raw, extrusion, or microwave-heat stabilized bran were kept either in polyethylene zipper-top bags or in vacuum-packed polyethylene bags for 0, 2, 4, 6, 8 and 12 weeks. Samples were in use for proximate analysis at 0 and 12 weeks and at two-week intervals for moisture, protein, lipid, carbohydrate and ash content [1], FFA [2] and crude fiber [1].

III. RESULT AND DISCUSSION

A. Free Fatty Acids (FFA)

Interaction between methods of heating and packaging indicated that in raw samples FFA increased steadily throughout the storage period, and zipper-top bags samples indicated more increase in FFA level than samples in vacuum bags (Table 1). There was no any significant increase regardless of packaging methods and microwave-heated. Since the storage time indicated significant interaction with other factors, comparison of means were analyzed within each level of storage time.

Variables	Parameters	
	Crude fibers	FFA
Microwave-heated (M)	S	S
In vacuum bag (V)	NS	S
Storage time (P)	S	S
MxV	NS	NS
VxP	NS	NS
MxVxP	S	S

Table 1. The analyses of variance at 5 percent level of significance of the crude fibers and fatty acids of the microwave-heated, vacuum bag and the storage time rice bran and their interaction.

Note: S = Significant difference
NS = Non significant different

Stabilization of rice bran by microwave heating and packaging method was tested for FFA content over a 12-week storage period at two-week intervals. In figure 2, the FFA values are presented for microwave-heat and packaging rice bran in vacuum packs and zipper-top bags throughout storage. In the control, the FFA content increased during storage from an initial value 3.69 % to a final value of 49.8% in vacuum packs and 52.1% in zipper-top bags. These increments were significant (p-value < 0.05). The rate of FFA formation was even quicker in zipper-top bags samples after 4 weeks of storage.

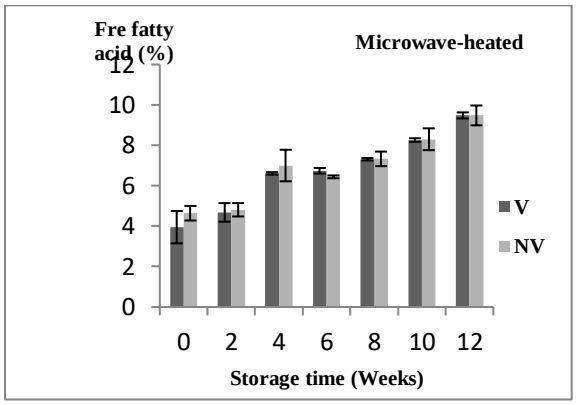


Fig 1:- The alteration of free fatty acid of the microwave-heated rice bran in vacuum bag (V) and in zipper-top bag (NV) during storage for 12 weeks.

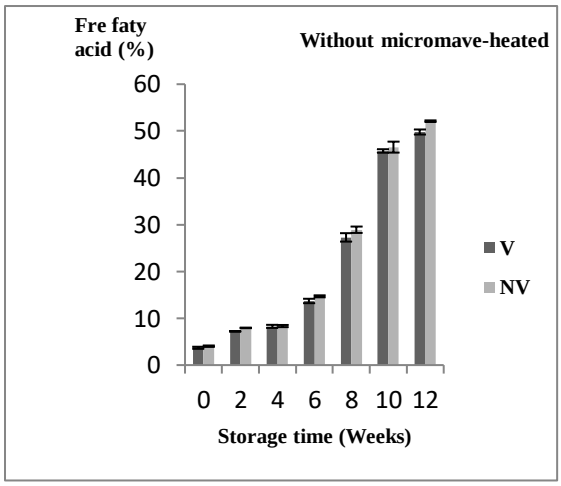


Fig 2:- The alteration of free fatty acid of the without microwave-heated rice bran in vacuum bag (V) and in zipper-top bag (NV) during storage for 12 weeks.

Although storage of raw bran at 25 ºC greatly increased the FFA level in the vacuum-packed samples with an increase of storage time, the increase was greater in zipper-top bag samples (Figure 2). Takano [24] noticed that the same pattern in brown rice stored in bags and vacuum-packed samples. This could be because the removal of air and oxygen by vacuum processing activates anaerobic microorganisms with higher lipolytic enzyme activity present in raw rice bran. Lipases, both endogenous to the bran and of microbial origin, initiate hydrolytic deterioration of kernel oil [7]. Surface damage during dehulling fragment the aleurone and germ (where oil is located), and lipase-producing mold and bacteria present on kernel surfaces would interact with bran oil [7] and the rise of FFA.

In this study, in microwave-heat stabilized rice bran, the FFA level increased slightly above 10% in samples stored at room temperature (25 ºC) (Figure 1). There was

ISSN No:-2456-2165

not a significant difference in FFA content between vacuum packing and zipper-top bags. This could be because microwave heat destroyed bacteria (especially anaerobic) present in rice bran. Rice bran with more than 5% FFA is considered unsuitable for human consumption [25]. The rate FFA formation in bran or brown rice flour is high. Approximately 30% of the oil can be converted to FFA within a week under high humidity and temperature conditions [7], therefore the rice bran control (without heating) but packed both in zipper bag and vacuum bag had rise apparently during storage.

According to Nordin [13], stated that microwave heating is only able to inhibit some lipase enzyme activity, therefore the addition of heating time becomes very important. The concentration of free fatty acids rice bran in this study was in line with the results of other studies such as [12] and [5], confirmed that free fatty acids of rice bran increased as the length of storage time continued. The level of free fatty acids of the microwave-heated rice bran was lowering significantly than that of without microwave-heated.

B. The proximate content

Interaction between heating methods and packaging methods indicated that in raw samples moisture increased steadily throughout the period of storage. The zipper-top bags samples showed more increase in moisture level than samples in vacuum bags. In contrast to protein samples, both microwave-heated and unheated (raw samples) reduce steadily and vacuum bags samples showed less decrease than samples in zipper-top bags. Microwave-heated did not show any significant increase deal with of packaging methods. Since the storage time indicated significant interaction with other factors, comparison of means were analyzed within each level of storage time. There was no interaction have an effect on showed on lipid, carbohydrate and ash rice bran content (Table 2)

Variables	Parameters				
	Moisture	Ash	Protein	Fat	Carbo hydrate
Microwave-heated (M)	S	NS	NS	S	S
Vacuum packaging (V)	S	NS	S	S	S
Storage time (P)	S	NS	S	S	S
MxV	NS	NS	NS	NS	NS
VxP	NS	NS	NS	NS	NS
MxVxP	S	NS	S	NS	NS

Table 2. Analyses of variance at 5 percent of significant level of the proximate rice bran microwave-heated, vacuum packaging, storage time and their interactions

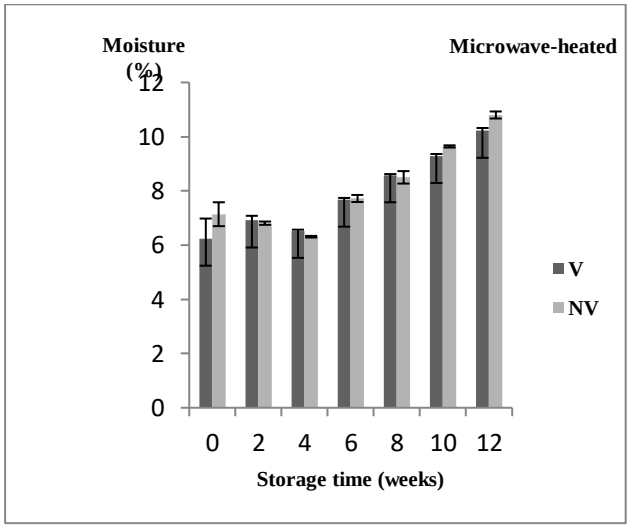
Note : S = significant difference
NS = non significant difference

C. Moisture

Generally, the moisture content of rice bran with microwave heating during storage is less than 10% (Figure 2), in contrast to the moisture content of rice bran without microwave heating that has reached more than 10% since the 4 weeks storage (Figure 2b). Moisture content of rice bran in vacuum bags is lower than that in zipper-top bag. Moisture content of rice bran without microwave-heated and in vacuum bag ranged from 8.42 ± 0.74% to 13.66 ± 0.1%; while the moisture content of the bran in zipper-top bag ranged from 9.16 ± 0.12% to 14.21 ± 0.18% (Figure 3).

The results of this study are almost the same as the level of bran-stabilized rice bran obtained by [4], except the moisture content and ash content of rice bran. The moisture and ash content differed significantly. Bhosale and Vijayalakhsmi [4] found that the microwave-stabilized rice bran contained 4.3% moisture, 17.5% protein, 13.10% fat, 4.92% ash and 52.33% carbohydrate. According to Saunders [19], rice bran composition was 8 - 15% moisture, 8 - 17% ash, 6 - 14% crude fiber, 11-17% protein, and 12-22% fat. The premium rice bran had moisture content less than 10%, ash maximum 8%, crude protein at least 11% and crude fiber maximum 7%, crude fat at least 12%. Meanwhile, rice bran met the quality II criteria if it had a maximum moisture content of 12%, ash maximum 8%, crude protein at least 9% and crude fiber maximum 12%, crude fat at least 9%. Therefore, rice bran of this work met the criteria of the quality II rice bran.

The microwave-heated and vacuum packaging rice bran predominantly consists of carbohydrate (62% wb), protein (10% wb) and lipid (10% wb). The ash content was around 9% throughout the storage.



ISSN No:-2456-2165

Fig 3:- The alteration of the microwave-heated rice bran moisture in zipper-top bag (NV) and vacuum bag (V) during storage for 12 weeks.

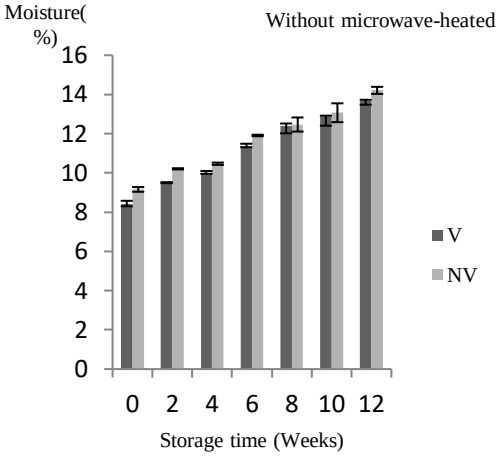


Fig 4:- The alteration of the without microwave-heated rice bran moisture in zipper-top bag (NV) and vacuum bag (V) during storage for 12 weeks.

D. Protein

The protein content of the rice bran with microwave heating decreased with increasing storage time, both rice bran and vacuum packaging (Figure 5). The protein content of rice bran in zipper-top bag is lower than that in vacuum bags. The protein content of rice bran with microwave heating and in vacuum bags at 12 weeks storage ranged from 8.4 ± 0.33% to 10.77 ± 0.46% (Figure 3). The rice bran protein of microwave-heated and in vacuum bags was higher than of in zipper-top bags. The protein levels of microwave-heated rice bran increased up to 4 weeks storage and then decreased. However, the protein content is not lower than the initial rice bran protein as shown in Figure 3. The protein content of rice bran with microwave heating either in vacuum or in zipper-top decreased when storage time was extended. The results of this study did not agree to the results of [12] which claimed that the stabilization of rice bran with microwave did not change the protein and fat content of rice bran of storage 16 weeks in ambient temperature.

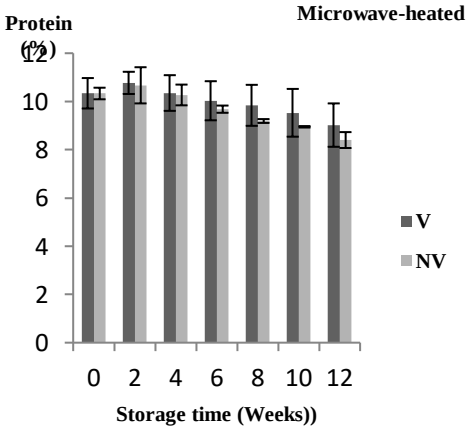


Fig 5:- The alteration of the microwave-heated rice bran protein in zipper-top bag (NV) and vacuum bag (V) during storage for 12 weeks.

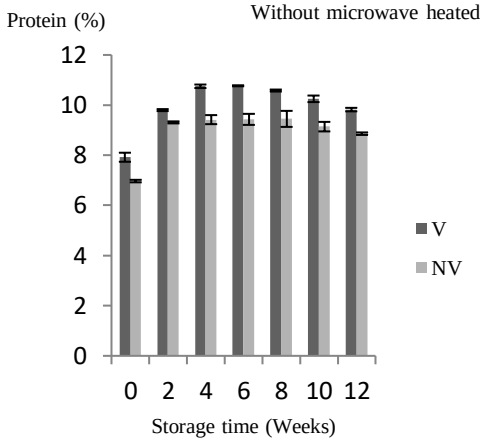


Fig 6:- The alteration of the without microwave-heated rice bran protein in zipper-top bag (NV) and vacuum bag (V) during storage for 12 weeks.

E. Fat, Ash and Carbohydrates

The microwave-heated rice bran had higher levels of fat, ash and carbohydrates if it compared to the without microwave-heated rice bran as shown in Figure 6. Fat content, ash and carbohydrate of rice bran with microwave heating ranged from 10.55 ± 1.33%; 9.4 ± 0.6% and 62.23 ± 3.05%, respectively. On the other hand of the fat, ash and carbohydrate content of the without microwave-heated rice bran, ranged from 9.09 ± 0.14%; 9.08 ± 0.62% and 60.97 ± 1.06% (Figure 6). The rice bran in vacuum bags gave higher in fat and ash content than the rice bran in zipper-top bag. In contrast to for their carbohydrate (Figure 6).

The fat, ash and carbohydrate of rice bran tend to decrease during storage. The lowest levels of fat and ash content of rice bran are shown by 12 weeks storage, while the lowest carbohydrate levels are shown by 10 weeks storage. The fat and ash of rice bran of 12 weeks storage were 7.58 ± 0.72% and 7.05 ± 0.58, respectively. Meanwhile, carbohydrate content of rice bran of 10 weeks storage was 61.11 ± 1.9% (Figure 8).

ISSN No:-2456-2165

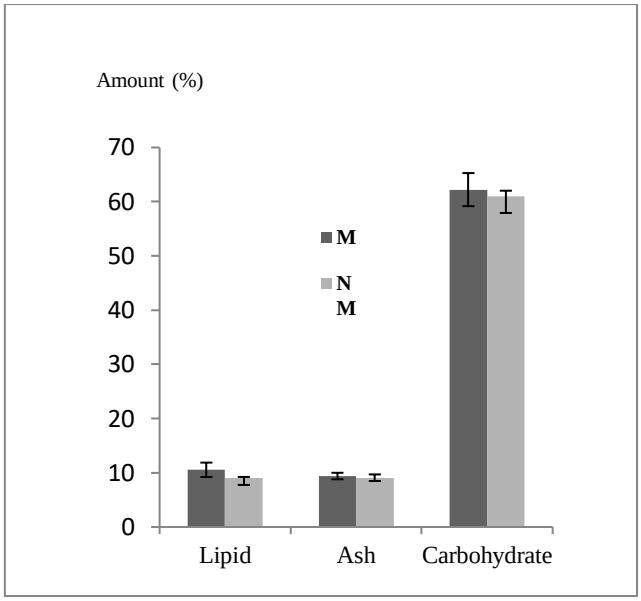


Fig 6:- The amount of lipid, Ash, and carbohydrate of the microwave-heated (M) and without microwave-heated (NM) rice bran.

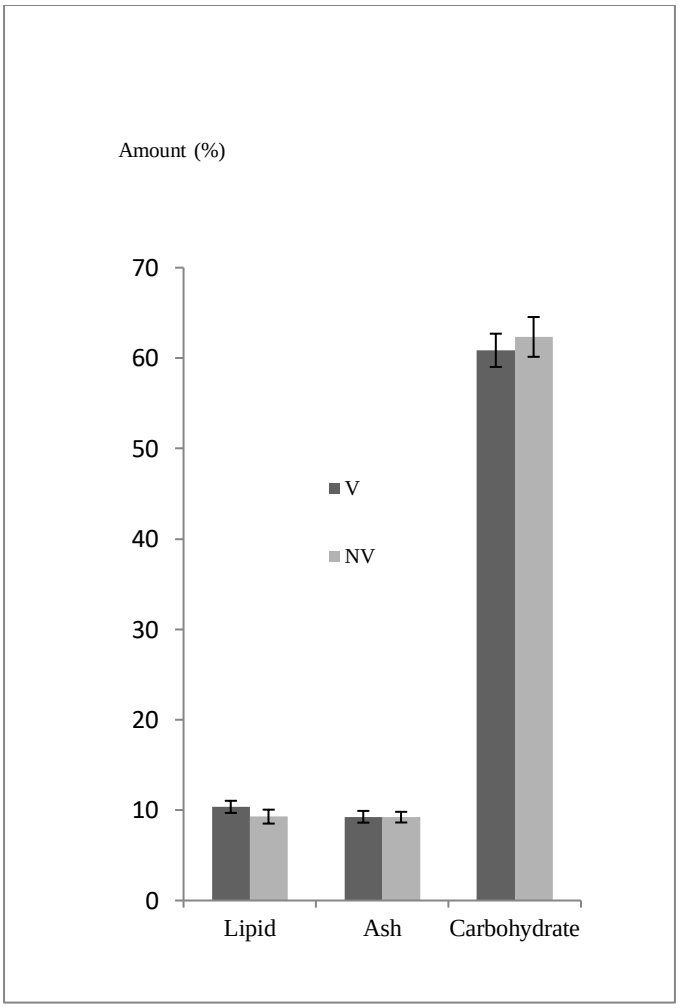


Fig 7:- The amount of lipid, ash, and carbohydrate of the vacuum bag (V) and the zipper-top bag (NV) rice bran.

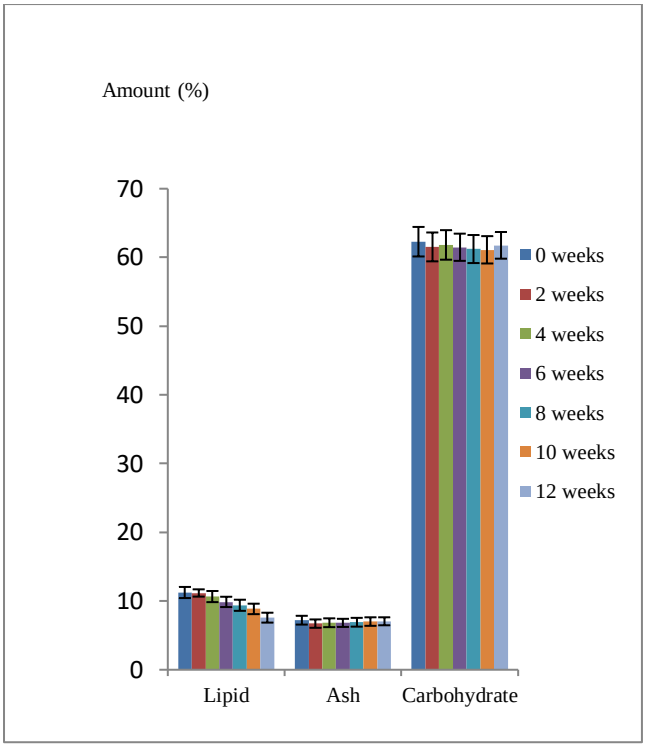


Figure 8**.** The amount of lipid, ash, and carbohydrate of the rice bran during 12 weeks storage in ambient temperature

F. Crude Fibers

Table 2 showed the analyses of variance at 5 percent of significant level of the crude fibers and fatty acid rice bran of microwave-heated, vacuum packaging, storage time and their interactions. The levels of crude fiber were influenced by the interaction of heating, packing and storage of rice bran. Changes in the crude fiber of microwave-heated, packaging and stored for 12 weeks are shown in Figure 5.

G. Crude Fibers

Crude fiber of rice bran decreased during 12 weeks' storage with either microwave heating or without heating and vacuum bags or in zipper-top bags packaging (Figure 9). The crude fiber content of bran with microwave heating is lower than that of without heating, either in vacuum-packed or non-vacuum-packed. The crude fiber of the rice bran in vacuum bags is higher than that of in zipper-top bags. The rice bran occurred in microwave heating in zipper-top bag at 12 weeks storage had the lowest content of crude fibers (6.68 ± 0.56%) as shown in Figure 9.

The crude fiber of microwave- heated rice bran in vacuum bags decreased to about 7% in 12 weeks storage, but in zipper-top bags, the crude fiber of rice bran at 12 weeks storage drops to 6%. However, the crude fiber of rice bran without microwave-heated in vacuum bags in 12 weeks storage was much higher than that of the microwave-heated. The crude fibers of the rice bran were 10% and 9%, respectively. The crude fiber content of rice bran was one of the limiting factors for feed or food. Rice bran with high crude fiber will inhibit the absorption of protein and mineral for growth. Rice bran contains crude fiber ranging from 6 to 14% [11]. This study showed that non-vacuum packaging was more effective in lowering the crude fiber content of

ISSN No:-2456-2165

rice bran compared to vacuum packaging. Therefore, microwave heating and non-vacuum packaging (in zipper-top bags) was an effective way to reduce the crude fiber of rice bran. The lowest crude fiber content was obtained from microwave-heated rice bran in zipper-top bags (non vacuum packaging) and stored for 12 weeks at ambient temperature (6.68 ± 0.56%).

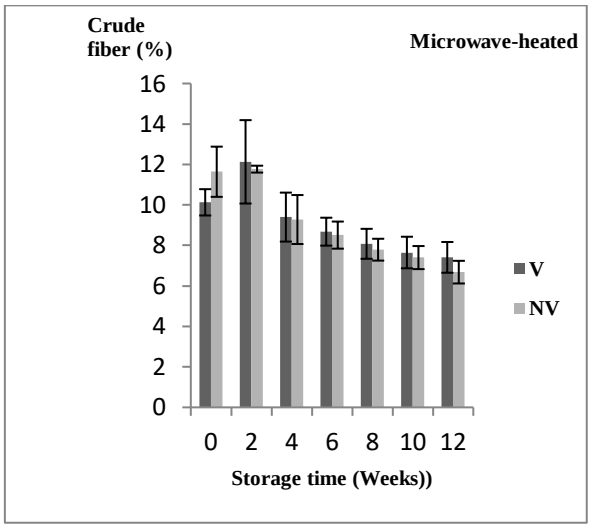


Fig 9:- The alteration of crude fiber of the microwave-heated rice bran in vacuum bag (V) and in zipper-top bag (NV) during storage for 12 weeks.

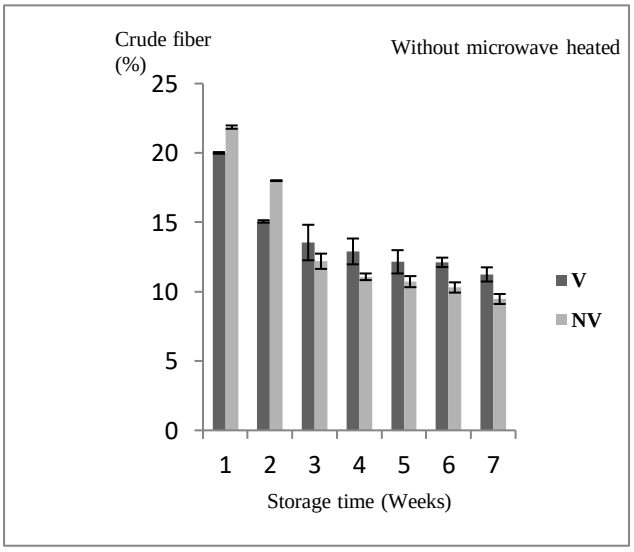


Fig 10:- The alteration of crude fiber of the without microwave-heated rice bran in vacuum bag (V) and in zipper-top bag (NV) during storage for 12 weeks.

IV. CONCLUSION

The free fatty acid of the rice bran increased during storage. The elevated levels of free fatty acid rice bran found in the microwave-heated rice bran during 12 weeks storage (less than 10%). The free fatty acid content of non-microwave heating rise bran was 49.79 ± 0, 54%. The crude fiber of rice bran both with microwave heating and without heating and vacuum packing decreased during storage. Microwave heating and non-vacuum packing effectively reduce the crude fiber of the rice bran. The lowest crude fiber content (6.68 ± 0.56%) _was obtained from the microwave-heated rice bran and packed in no vacuum (zipper-top bags) and stored for 12 weeks.

Microwave heating can maintain the rice bran moisture content of less than 8% until 6 weeks of storage either with vacuum or non-vacuum packaging. The protein content of rice bran with microwave heating did not change significantly during the 12 weeks storage in both vacuum and non-vacuum packaging. The rice bran protein ranged from 8.4 ± 0.33% to 10.77 ± 0.46%. Interaction between microwave heating, packaging methods and the length of storage did not effect on the rice bran fat, ash and carbohydrate. However the rice bran fat, ash and carbohydrate of microwave heating were higher than that of without heating. The rice bran in vacuum packaging was higher in total fat, ash and carbohydrate levels than without vacuum. The fat, ash and carbohydrate of the microwave-heated rice bran were 10, 55 ± 1.33%; 9.4 ± 0.6% and 62.23 ± 3.05% respectively.

ACKNOWLEDGEMENT

This experiment was supported by the Ministry of Research, Technology and Higher Education Republic of Indonesia. I would like also thank to the staff of the Laboratory of Food Biochemistry, Faculty of Food Technology University of Mataram.

REFERENCES

[1]. AACC, 1995. Approved methods of the American association of cereal chemists (9th ed.). Minnesota: St Paul.
[2]. AOCS, 1989. Official Methods and Recommended Practices, fourth ed. American Oil Chemists' Society, Champaign. Method Ca 5a - 40.
[3]. Bertrand, K., 2005. Microwavable foods satisfy need for speed and palatability. Food Technol. 59: 30–34.
[4]. Bhosale S, Vijayalakshmi D., 2015. Processing and Nutritional Composition of Rice Bran. Curr Res Nutr Food Sci 3(1) : 1 – 5.
[5]. Boldina, A.A, 2014. Developing Methods and Optimal Conditions of Rice Bran Processing with the Purpose of Increasing its Storage Stability. European Online Journal of Natural and Social Sciences. 3 (3) : 619 – 627.
[6]. BPS, 2008. Indonesia Statistic. Jakarta.
[7]. Champagne, E.T. and R.J. Hron Sr. 1992. Stabilizing brown rice to lipolytic hydrolysis by ethanol vapors. Cereal Chemistry. 69:152-156.
[8]. Choi, K., E.H. Marth, and P.C. Vasavada, 1993. Use of microwave energy to inactivate Listeria monocytogenes in milk. Milchwissenschaft 48 : 200–203.
[9]. Faria, S. A. S. C. , P. Z. Bassinello, M. V. C. Penteado, 2012. Nutritional composition of rice bran submitted to different stabilization procedures. Braz. J. Phar. Sc. 48 (4) : 651 – 657.
[10]. ----------, M. Alami, A. M. Zadegan, Y. Maghsoudlu, M.Ghorbani, A.D. Garmakhani, S.H. Mossavi, 2014. Functional and Physicochemical Properties of Iranian Rice Bran. Minerva Biotechnologica 26 (1) : 31 – 40.

[11]. Kean, T.L., 2010. Nutrient composition of Sabah rice bran (MR159, Kampung, and TQR-2) stabilized by refrigeration and microwave heating.Thesis. University of Malaysia, Sabah.
[12]. Malekian, F., R. M. Rao, W. Prinyawiwatkul, W. E. Marshall, M. Windhauser, and M. Ahmedna, 2000. Lipase and Lipoxygenase Activity, Functionality, And Nutrient Losses in Rice Bran During Storage. Louisiana State University Agricultural Center Bulletin No. 870
[13]. Nordin, N.N.A.M, R. Karim, H.M., Ghozali, N.M. Adzahan, and M.T. Sultan, 2014. Effects of various stabilization techniques on the nutritional quality and antioxidant potential of brewer's rice. J.of Eng. Sc. And Technol.9 (3) : 347 - 363
[14]. Oliveira, M.E.C. and A.S. Franca, 2002. Microwave heating of foodstuff. J. Food Eng. 53 : 347–359
[15]. Prabhakar, J.V.; and Venkatesh, K.V.L. (1986). A simple chemical method for stabilization of rice bran. Journal of American Oil Chemists' Society, 63(5), 644-646.
[16]. Ryynänen, S. And T. Ohlsson, 1996. Microwave heating uniformity of ready meals as affected by placement, composition, and geometry. J. Food Sci. 61: 620–624.
[17]. Rao, A. S., Redd, S. G., Babu, P. P. and Reddy, A. R., 2010 The antioxidant and antiproliferative activities of methanolic extracts from Njavara rice bran. BMC Complementary and Alternative Medicine. **10**(4): 1-9.
[18]. Rose D.J, L.V Ogden, M.L. Dunn , and O.A. Pike, 2008. Enhanced lipid stability in whole wheat flour by lipase inactivation and antioxidant retention.Cereal Chemistry. 85 (2) : 218-223.
[19]. Saunders, R.M., 1990. The properties of rice bran as a foodstuff. Cereal Foods World 35 (7) : 632 – 636.
[20]. Shaheen, M.S., K. F. El-Massry, A. El-Ghorab and F.M. Anjum, 2012. Microwave Applications in Thermal Food Processing. In Tech
[21]. Shastry, B.S. and M.R. Raghavendra Rao. 1975. Studies on lipoxygenase from rice bran. Cereal Chemistry. 52 (5) :597-603 http://creativecommons.org /licenses/by/3.0. Diakses tanggal 18 Mei 2016
[22]. Sierra, I., C. Vidal-Valverde, and A. Olano, 1999. The effects of continuous flow microwave treatment and conventional heating on the nutritional value of milk as shown by influence on vitamin B1 retention. Eur. Food Res. Technol. 209: 352–354.
[23]. Senecdor, G.W, and W.G. Cochran, 1994. Statistical methods, 8th ed. Iowa State University Press, Iowa
[24]. Takano, K. 1993. Mechanism of lipid hydrolysis in rice bran. Cereal Foods World. 38 (9):695-698.
[25]. Takahama, U., 1985. Inhibition of lipoxygenase-dependent lipid peroxidation by quercetin: Mechanism of antioxidative functions. Phytochem 24: 1443-1446.