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EFFECT OF THERMAL PROCESSING (PARBOILING AND EXTRUSION) ON STABILIZATION OF RICE BRAN DURING STORAGE

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ABSTRACT

The present investigation was carried out to study the effect of thermal processing (parboiling and extrusion) on rice bran stabilization during storage in striped plastic bags at room temperature for 8 weeks.

Results showed that, the moisture content of extruded rice bran was lower than that of untreated and parboiled rice bran. In addition, the moisture content of rice bran samples decreased with increasing storage period. Parboiling and extrusion processing decreased the free fatty acids of rice bran after 60 days compared with untreated rice bran. Thermal processing showed an increase in palmatic and oleic acids while linoleic and linolenic acids were decreased. Saturated fatty acids were increased after 8 weeks of storage period. Parboiled rice bran is higher in lipids content than that of untreated and extruded rice brans. Crude protein, ash and carbohydrate showed observed changes during storage.

INTRODUCTION

Rice bran, a by-product of milled rice, and its oil may have cardiovascular health benefits. Human consumption of rice bran had been limited primarily because of the rapid onset of rancidity in rice bran, but methods used to stabilize rice bran and to extract its oil have been developed (Demark-Wahnefried *et al.,* 1990).

In Japan, rice bran is one of the most abundant biomass, about 900 thousand tons are produced per year (Pourali *et al.,* 2009).

Rice bran oil (RBO) is not a traditional oil worldwide, but it is in steady demand as a so-called "health oil". Approximately 80 thousand tons of RBO, corresponding to only 3.5% of total edible oils, is consumed annually in Japan (Sugano and Tsuji, 1997).

Rice bran is rich in nutrients with 14-16% protein, 12-23% fat and 8-10% crude fiber. It is also a good source of B vitamins and minerals (Saunders, 1985).

However, only small portion (< 10.0%) of RBO is processed into edible oil (Zullaikah *et al.,* 2005); the reason is hydrolysis reaction of its triglyceriede into glycerol and free fatty acids (FFAS) with occurs soon after rice milling caused by the presence of lipase enzyme as catalyst (Ismail *et al.,* 2001).

Generally, rice bran oil (RBO) with an excess of 10% free fatty acids is unfit for human consumption (Teo *et al.,* 1993).

When thermal treatment is applied, the rice bran stabilization process consists of the destruction of active lipases and peroxidases (Ramezanzadeh *et al.,* 2000). The most effective classical methods include dry heat, moist heat and moist heat on press stabilization (Ramezanzadeh *et al.,* 1999).

Other methods include the use of chemical products, such as hydrochloric acid, acetic acid, acrylonitrile and propanal and stabilization by microwave (Prakash, 1996).

This work was undertaken to evaluate the stability of untreated, parboiled and extruded rice brans during 8 weeks of storage and thereby to extent their shelf life.

MATERIALS AND METHODS

Materials:

1. Rice Brain sample of rice variety namely (Giza 178) was obtained from the Rice Research and Training Center (RRTC) that located in Sakha at the Governorate of Kafr El-Sheikh, Egypt during season of (2008).
2. Striped plastic bags was used for packaging rice bran samples.

The packaged rice bran samples were stored at room temperature (28 $\pm$ 2 $^{\circ}$C) during summer for 8 weeks. Representative samples were withdrawn at regular intervals for further analytical processing.

Methods:

1. Preparation of parboiled paddy rice and its bran:

Parboiled rice (Giza 178 variety) was prepared by following the procedure of Singh *et al.*, (1999).

Parboiled rice bran obtained from milling parboiled paddy rice.

2. Extrusion stabilization of rice bran:

Rice brain was stabilized in the extruder at a temperature ranging from 125-130^{o}C for 30 sec. The bran temperature in the auger ranged from 97-99^{o}C. Stabilized rice bran was air cooled at room temperature and collected in striped plastic bags according to Abu-Foul (1990).

Free fatty acids was determined according to the methods of AOCS (1991).

Fatty Acid composition:

Fatty acid composition was determined by Gas liquid chromatography according to AOCS (1991).

Proximate Analysis:

Moisture, crude protein, total lipids and ash were determined by standard AOAC methods (AOAC, 1999), total carbohydrate was determined by difference using the following formula:

% Carbohydrate = 100- (% protein + % fat + % ash).

Statistical analysis:

Most of the obtained data were analyzed statistically using the analysis of variance and means were further tested using the least significant difference test (LSD) as outlined by steel and Torrie (1980).

RESULTS AND DISCUSSION

Moisture content (%):

Preliminary experiments showed that the presence of moisture greatly affects the FFA content of the oil extracted, as the lipase activity is higher in the presences of moisture (Gangodavilage, 2002). The obtained results of moisture content that given in Table (1) showed that the moisture content of extruded rice bran lower than those of untreated and parboiled rice bran. These results are in line with those of Cordero *et al.* (1985) and Yeo and Shibamoto (1991), who reported that moisture content depending on the processing temperature and time.

Apparent also from the same table that, the moisture content of rice bran samples decreased upon prolonging the storage (which could also be a contributing factor for increase in lipoxygenase activity of samples stored at room temperature). The obtained results are in line with those recorded by Dharmaputra (1997), who reported that during storage moisture content of rice bran decreased, this reduction in moisture content could be attributed to the higher temperature and lower relative humidity (RH) during storage.

Table (1): Effect of thermal processing (parboiling and extrusion) on the moisture content % of rice bran stored at room temperature.

Treatments / Storage period (weeks)	Untreated rice bran	Parboiled rice bran	Extruded rice bran
Zero	12.3 a	9.5 a	6.8 a
2	11.7 b	9.2 b	6.8 a
4	11.1 c	9.0 b	6.1 b
6	10.5 d	8.3 c	5.8 c
8	10.0 e	8.0 d	5.6 c

Each value is an average of three determination.
Values followed by the same letter in column are not significantly different P $\leq$ 0.05.

Free fatty acids (%):

Results presented in Table (2) show the effect of parboiling and extrusion on the free fatty acids of rice bran packaged in striped plastic bags and stored for 8 weeks at room temperature.

Table (2): Effect of thermal processing (parboiling and extrusion) on the free fatty acids content (%) of rice bran stored at room temperature (on dry weight basis).

Treatments / Storage period (days)	Untreated rice bran	Parboiled rice bran	Extrusion rice bran
	FFA content % as oleic acid		
Zero	4.5 m	3.2 m	4.0 k
5	20.0 L	9.5 L	4.3 j
10	27.3 K	12.4 k	4.5 j
15	32.7 J	16.6 j	4.8 i
20	38.5i	18.8 i	5.1 h
25	43.9 h	21.7 h	5.49 g
30	52.2 g	23.1 g	5.78 f
35	58.4 f	24.5 f	6.2 e
40	60.6 e	25.3 e	6.5 d
45	61.1 d	25.9 d	6.7 d
50	65.5 c	27.1 c	7.1 c
55	69.7 b	28.3 b	7.6 b
60	70.3 a	29.6 a	7.9 a

Each value is an average of three determination.
Values followed by the same letter in column are not significantly different P $\leq$ 0.05.

Generally, free fatty acids were taken as an index of rice bran stability. Parboiling and extrusion processes decreased the free fatty acids to 87.9% and 88.7%, respectively after 60 days compared with untreated samples.

Increasing amount of free fatty acids during storage might be attributed to the hydrolysis of rice bran oil triglyceride into free fatty acids. On the other hand, extrusion could effectively destroy the activity of lipase and produce a shelf stable rice bran. These results are in accordance with those reported by Randall *et al.* (1985), Prabhakar and Venkatesh (1986), Nasirullah *et al.* (1989) and Ismail *et al.* (2001).

Fatty acids composition:

Results presented in Table (3) show the fatty acids composition of rice bran oil extracted from untreated, parboiled and extruded rice bran. The major fatty acids are palmatic, oleic and linoleic acids which make up more than 90% of fatty acids. Thermal processing (parboiling and extrusion) showed an increase in palmatic and oleic acids, while linoleic and linolenic acids were decreased. Saturated fatty acids increased during storage while, unsaturated fatty acids showed a decrease during storage. The feasible reduction in oleic, linoleic and linolenic acids measures the increase in free fatty acids might expected during the storage. Consequently, these fatty acids were easy to decomposed depending upon the storage condition, especially oxidation reactions. Obtained results were in general agree with those obtained by Gupta (1989), Luh (1991) and Ismail (2001).

Table (3): Effect of thermal processing (parboiling and extrusion) on fatty acids composition of rice bran stored at room temperature.

Treatments	Fatty acids %					
	C14 Mgrstic	**C16 Palmitic**	**C18 Stearic**	**C18: 1 Oleic**	**C18: 2 Linoleic**	**C18: 3 Liolenic**
Untreated rice bran						
At zero time	0.82	17.5	2.30	43.18	33.58	2.6
After 8 weeks	0.98	20.1	2.71	41.92	31.90	2.32
Parboiled rice bran						
At zero time	0.71	17.8	2.10	43.58	33.30	2.50
After 8 weeks	0.86	19.8	2.45	42.25	32.22	2.40
Extruded rice bran						
At zero time	0.65	18.0	2.08	43.56	32.00	2.50
After 8 weeks	0.78	19.25	2.42	42.77	32.33	2.41

Proximate chemical composition of untreated rice bran compared to stabilized rice brans:

Chemical composition of untreated, parboiled and extruded rice bran were shown in Table (4). Parboiled rice bran is higher in oil content 23.1 than untreated rice bran 20.4%, but extruded rice bran is lower in oil content 18.7%. These data agree with earlier finding of Benedito de Barber *et al.* (1977), who reported that difference in composition between untreated, parboiled and extruded brans depend upon degree of milling and treatment condition. Protein percent in untreated, parboiled and extruded rice brans were 14.62, 14.91 and 15.1%, respectively.

There were no observed clear changes in protein and fat contents during storage. These results are in according with those reported by Wadsworth and Koltun (1986) and Yeo and Shibamoto (1991). But ash and carbohydrate contents showed observed changes during storage. The results from this study agree with the previous finding of Sarkar and Bhattacharyya (1989) and Orthoefer (1996).

Table (4): Effect of thermal processing (parboiling and extrusion) on proximate chemical composition of rice bran stored at room temperature for 8 weeks (on dry weight basis).

Treatments	Chemical composition %			
	Crude protein	**Total lipids**	**Ash**	**Carbohydrate***
Untreated rice bran				
At zero time	14.62 a	20.4 b	9.1 c	55.88 b
After 8 weeks	14.90 a	20.8 b	9.9 a	54.36 c
Parboiled rice bran				
At zero time	14.91 a	23.1 a	8.8 d	53.19 d
After 8 weeks	15.10 a	23.4 a	9.5 b	52.0 e
Extruded rice bran				
At zero time	15.10 a	18.7 c	9.3 b	56.9 a
After 8 weeks	15.30 a	18.9 c	9.8 a	56.0 b

***Carbohydrate = 100-(protein + oil + ash)**
Each value is an average of three determination.
Values followed by the same letter in column are not significantly different P $\leq$ 0.05.

CONCLUSION

Data collected from the two phases of this experiment indicate that extrusion stabilization of rice bran has advantages over parboiling.

REFERENCES

Abu-Foul, N.S.I. (1990). Physical-chemical, nutritional and technological studies on food uses of glanded and glandless cottonseed protein. Ph.D. Thesis, Fac. of Agric. Alex. Univ., Egypt.

AOAC (1999). Association of Official Analytical Chemists, 14th ed. Gaithersbug; Ed. AOAC International.

AOCS (1991). American Oil Chemist Society. Official Method Celb-89.

Benedito de Barber, C.; Martinez, J. and Barber, S. (1977). Effects of parboiling processes on the chemical composition and nutritional characteristics of rice bran. In Proc. Rice By-Products Util. Int. Conf., 1974. Valencia, Spain. Vol. IV. Rice Bran Utilization: Food and Feed. Barbers and Tortosa, E. (Editors). Inst. Agric. Chem. and Food Tech. Valencia, Spain.

Cordero, V.; Benedito de Barder, C.; Clements, G. and Prina, E. (1985). In activation of rice bran enzyme. Revista de Agroquimica-Y-Technologia de Aliments 25: 75-86.

Demark-Wahnefried, W.; Bowerinc, J. and Cochen, P.S. (1990). Reduced serum cholesterol with dietary change using fat-modified and oat bran supplemented diets. J. Am. Diet. Assoc. 90: 223-229.

Dharmaputra, O. (1997). The effects of milling degree and type of bag on fungal infection and some chemical contents of stored milled rice. Biotropia., 10: 42-62.

Gangodavilage, N.C. (2002). Optimal operating conditions and equilibrium characteristics of rice bran oil extraction. M.Sc. Thesis, University of Moratuwa, Sir Lanka.

Gupta, H.P. (1989). Rice brain offers Indian oil source. J. AOCS, 66(5): 620-623.

Ismail, F.A.; El-Dash, J.M. and Tawfeek, M. (2001). Effect of stabilization techniques on quality characteristics of rice bran. Bulletin of Faculty of agric. Cairo Univ. 573-58: 52(4).

Luh, B.S. (1991). Rice utilization. Vol. II. Published by van Nostrand, Reinhold, New York, pp. 305-308.

Nasirullah, ; Krishnamurthy, M.N. and Nagaruja, K.V. (1989). Effect of stabilization on the quality characteristics of rice bran oil. J. AOCS, 66(5): 661-663.

Orthoefer, F.T. (1996). Rice bran oil: Healthy lipid source. Food Tech. (50): 62-64.

Parbhakar, J.V. and Venkatesh, K. (1986). A simple chemical method for stabilization of rice bran. J. AOCS. 63: 644-646.

Pourali, O.; Ashari, F. and Yosheda, H. (2009). Simultaneous rice bran oil stabilization and extraction using sub-critical water medium. J. of Food Engineering. 95: 510-516.

Prakash, J. (1996). Rice bran proteins: Properties and food uses. Critical Review of Food Sci. Nutri., 36(6): 537-552.

Ramezanzadeh, F.M.; Rao, R.M.; Prinyawwathul, W.; Marshall, W.E. and Windhauser, M. (2000). Effects of microwave heat, packaging, and storage temperature on fatty acids and proximate compositions in rice bran. J. Agric. and Food Chem. 48(2): 464-467.

Ramezanzadeh, F.M.; Rao, R.M.; Windhauser, M.; Prinyawwatkul, R.T. and Marshall, W.E. (1999). Prevention of hydrolytic rancidity in bran during storage. J. of Agric. and Food Chem., 47. 3050-3052.

Randall, J.M.; Sayre, R.N.; Schulz, W.C.; Fong, R.Y.; Mossmann, A.P.; Tribelhorn, R.E. and Sounders, R.M. (1985). Rice bran stabilization by extrusion cooking for extraction of edible oil. J. Food Sci. 50(2): 361-364.

Sarkar, S. and Bhattacharyya, D.K. (1989). Studies on characteristics of rice bran. J. Oil Technologists Association of India, 21(1): 11-12.

Saunders, R.M. (1985). Rice bran: Composition and potential food sources. Food Rev. Int. 1(3): 465-495.

Singh, S.; Kall, M. and Malhotra, S.R. (1999). Effect of parboiling, hand-pounding and machine milling on chemical composition of rice. J. Food Sci. Tech., 36(5): 434-435.

Steel, R.G. and Torrie, J.H. (1980). Principles and procedures of statistics. 2nd Ed. pp. 120. McGraw-Hill, New York, USA.

Sugano, M. and Tsuji, E. (1997). Rice bran oil and cholesterol metabolism. J. Nutr. 127: 5215-5245.

Teo, J.; Rao, R. and Liuzzo, J. (1993). Thermal efficiencies of conventional and microwave. Heat Stabilization of rice bran. Louisiana Agriculture. 36(3): 15.

Wadsworth, J.I. and Koltun, S.P. (1986). Physiochemical properties and cooking quality of microwave dried rice. J. Agric. and Food Chem., 39: 1860-1862.

Yeo, H. and Shibamoto, T. (1991). Effect of moisture content on the maillard Browning Model System upon microwave irradiation J. Agric. and Food Chem. 48(2): 464-467.

Zullaikah, S.; Lai, C.; Vali, S. and Ju, Y. (2005). A two-step acid-coatalyhzed process for the production of biodiesel from rice bran oil. Bioresoure Tech., (96): 1889-1896.

تأثير المعاملة الحرارية (الغلى والبثق الحرارى) على ثبات رجيع الارز اثناء التخزين

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اجريت هذه الدراسة بهدف دراسة تأثيرالمعاملة الحرارية (الغلى والبثق الحرارى) على ثبات رجيع الارز اثناء التخزين فى عبوه من شتائر البلاستيك لمدة ٨ اسابيع وكانت النتائج المتحصل عليها كالتالى:

- نسبة الرطوبة فى رجيع الارز المعامل بالبثق الحرارى كانت اقل من الرجيع الغير معامل والرجيع المعامل بالغلى علاوه على ذلك فان نسبة الرطوبة فى رجيع الارز تقل مع فترات التخزين.
- عملية الغلى والبثق الحرارى قللت من الاحماض الدهنية الحره خلال فترة التخزين (٦٠ يوم) بالمقارنة برجيع الازر الغير معامل.
- المعاملة الحرارية أدت الى زيادة احماض البالمتيك والاوليك بينما قللت من نسب احماض اللينوليك واللينولينيك اما الاحماض الدهنية المشبعة فقد زادت اثناء التخزين.
- أدت عملية الغلى الى زيادة نسبة الدهن فى الرجيع بالمقارنة بالرجيع الغير معامل أو المعامل بالبثق الحرارى.
- كذلك وجد نقص ملحوظ فى الرماد والكربوهيدات اثناء فترة التخزين لرجيع الارز المعامل بالحرارة والغير معامل.

مما سبق نستنتج ان المعاملة الحرارية تؤدى بصفةعامة الى زيادة ثبات رجيع الارز اثناء التخزين وقد تميزت المعاملة الحرارية بالبثق الحرارى على معاملة الغلى فى هذا الشأن.

قام بتحكيم البحث

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