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EFFECT OF STABILIZATION TECHNIQUES ON QUALITY CHARACTERISTICS OF RICE BRAN

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ABSTRACT

The effect of heat and extrusion stabilization on the quality characteristics of rice bran and its oil were studied. Acid value, expressed as milligram potassium hydroxide per gram rice oil was taken as an index of rice bran stability. Heat stabilization at 130°C and 15 min., and extrusion stabilization at 130°C and 150 rpm decreased the acid value to 5.6 and 7.7, respectively after 55 days compared with control, which has an acid value of 102.53. Extrusion at 130°C and 150 rpm could effectively destroy the activity of lipase and produces a shelf stable rice bran which has an acid value of 8.7 after 3 months. Fatty acids of rice bran oil extracted from untreated, heat stabilized and extrusion stabilized rice bran were identified. The major fatty acids are palmitic, oleic, and linoleic, which make up more than 90% of fatty acids. Heat stabilization showed an increase in palmitic and oleic, while linoleic and lenolenic were decreased. Extrusion showed an increase of oleic and lenoleic acids. Rice bran was found to be rich in calcium and phosphorus. It also contains Fe,Cu, Zn,Mg, Mn, K, Na, Cu. Mineral content was unaffected by the heat and extrusion stabilization. The essential amino acids in rice bran are leucine, valine, lysine, and phenyl alanine, while non-essential amino acids are glutamic and aspartic acids. Heat and extrusion treatments decreased most of the amino acids in rice bran.

Stabilization of rice bran is a practical procedure to utilize by-products of rice milling industry.

***Key words:**, extrusion technology , rice bran , stabilization.*

1.INTRODUCTION

Rice bran is a by-product obtained during rice milling, making up to about 10% of rice grain. It is rich in protein (13- 16%) and oil (15-22%), Daniel *et al.,* (1991). If the oil is not extracted immediately from the bran, it will be hydrolyzed into free fatty acids (FFA) and glycerol by active lipase enzymes. The rate of oil degradation and FFA formation is very high (about 5-7 % per day and up to 70% in a month) as reported by Tao *et al.,* (1993).

Once bran is stabilized it could be transported and stored for 30-60 days at ambient condition without appreciable increase in FFA content, (Daniel *et al.,* 1993).

Rice bran, stabilized by microwave heating at 2450 MHZ for 3 min., was found to be stable for up to four weeks in storage. Free fatty acids (FFA) values of microwave treated bran increased from 4 to 4.9 in long grain rice bran and from 4.6 to 6.25% in medium grain rice bran, (Tao *et al.,* 1993).

Parboiling of paddy rice was used to obtain parboiled rice bran from different varieties. Paddy rice was immersed in water preheated to 100°C and allowed to soak for 18 hr. The soaked paddy rice was steamed for 25 min. and dried in the sun to 14% grain moisture (Palipane and Swarnasiri, 1985).

The effects of acid, heat and cold stabilization on the quality characteristics of rice bran were studied. Free fatty acid values of the un-stabilized oil showed an increase from 4.8 to 20.3 within 7-days period. The corresponding oil from rice bran which was stabilized by acid, heating and cooling showed an increase in acid value only from 4.8 to 4.8,5.0 and 6.0, respectively. (Nasirullah *et al.,* 1989).

The effects of heat treatment on lipid oxidation in rice bran were studied by Hwang and Jung (1996). In Rice bran samples treated at 70, 90 or 105°C for 0 – 120 min., moisture content decreased with increasing duration of heat treatment. Fatty acid formation was retarded when the bran was treated for 2 hr. at 90°C or 1 hr. at 105°C. Peroxide value did not show any significant change.

An extrusion treatment procedure was used by Randall *et al.,*(1985) for producing stable rice bran. They found no significant increase in free fatty acid content for at least 30-60 days. In the optimum process, rice bran of 12-13% moisture content, was extruded at 130°C and held 3 min. at 97-99°C before cooling. Stabilized rice bran contained 6-7% moisture.

Daniel *et al.*,(1991) stabililized rice bran by using a single screw food extruder. Four processing temperatures, and three post dwell times were evaluated using free fatty acid and thiobarbituric acid contents for product stability determination. After 165 days, oxidative rancidity was minimized at 110°C, while 120°C protected best against hydrolytic rancidity.

The effect of extrusion processing on phytic acid, soluble and insoluble fiber contents was studied using screw speeds of 50, 70, and 100% of maximum rotation per min. (Guallerto *et al.*,1997). They found that extrusion did not affect the insoluble fiber content of wheat bran. However, a reduction in this component was observed in rice and oat brans,

The aim of the present study was to develop an acceptable technique for rice bran stabilization and to evaluate the nutritive value of the stabilized rice bran.

2. MATERIALS AND METHODS

Rice variety Giza 176 was obtained from Rice Technology Training Center at Sakha, Agriculture Research Center. Freshly milled rice bran was chemically analyzed. Moisture, crude protein, crude oil, crude fiber, ash were determined according to A.O.A.C., (1990). Total soluble sugars was determined according to Dubois *et al.,* (1956). Starch was determined as described by Ghali and Ghanam., (1967). Dietary fibers of deffated rice bran were determined as described by Prosky *et al., (*1988).

Stabilization of rice bran: the following different techniques were applied

1-Microwave treatment: Samples of rice bran containing 12 % moisture, or 20% moisture were placed in a microwave oven for 3 min. as recommended by Rhee and Yoon (1984).

2-Parboiling: Paddy rice was immersed in water preheated to 100°C and allowed to soak for 18hr. The soaked paddy rice was steamed in an autoclave at 1.5 A.S.P., 121°C for 15 min. The steamed rice was dried at room temperature to 14% moisture.

3-Dry heating. A sample of rice bran placed in an electric oven and heated at 130°C for 15min.

4-Extrusion of rice bran: Rice bran was processed using a single screw food extruder at 110, 130, 150°C, as described by Martin *et al.*, (1992). The bran feed rate was 50 gm/min and screw speed was 50, and 150 r.p.m..

The stabilized rice bran samples were stored for 3 months at room temperature. Acid value was determined in the oil at zero time and followed weekly. Fatty acids of heat and extrusion stabilized rice bran were identified by gas-liquid chromatographic technique (G.L.C.) and compared with untreated rice bran according to Vogel, (1975). Minerals were determined by atomic absorption according to the methods of A.O.A.C. (1990). Amino acids were determined by using amino acid analyzer according to the method described by Oleson *et al.*, (1975.).

3. RESULTS AND DISCUSSION

3.1. Chemical composition of rice bran

Table (1) shows the chemical composition of untreated, heat and extrusion stabilized rice bran. The data showed that the moisture content of rice bran was decreased when processed by dry heating (2.9%) compared with control (12.85), and its oil, protein and ash contents were increased.

Table(1): Chemical composition(%) of untreated, heat and extrusion stabilized rice bran (on dry basis*).

Components	Control (Untreated)	Dry heating 130°C ,15 min.	Extrusion 130°C at 150 r.p.m.
Protein	12.3	12.6	14.7
Oil	17.5	17.9	14.1
Ash	7.28	9.9	8.4
Crude Fiber	15.1	13.56	13.98
Dietary Fiber	33.88	35.8	36.56
Starch	30.19	28.47	27.47
Total sugar	9.8	13	14.7

* The moisture contents were 12.85%, 2.9%,and 7.75%for control, drying, and extrusion samples, respectively

Moreover, the results presented in Table (1) showed that extrusion of rice bran at 130°C and 150 r.p.m decreased moisture and oil contents to 7.75 and 14.1% respectively, compared to control vof 12.85 and 17.5% respectively, while protein and ash contents were increased. Dietary fibers content (36.56%) increased relative to the control (33.88%).

3.2. Stabilization techniques of rice bran

Tables (2-3) reveal that the acid value of untreated rice bran increased from 5.7 at zero-time to 34.9 after 7 days and to 107.27 and 120.14 after two and three months, respectively. Rice bran which was stabilized by dry heat showed no increase within 7 days of storage and increased

Table (2): Effect of bran stabilization by microwave (at 12 and 20% initial moisture for 3 min.), parboiling and heating (130°C for 15 min.) and storage at room temperature on acid values of rice bran oil.

Storage days	Control *A.V.	**SRB Microwave moisture12%. *A.V.	**SRB Microwave Moisture 20% *A.V.	**SRB parboiling *A.V.	**SRB (130°C 15 min). *A.V.
0	5.7	6.51	9.82	4.1	4.4
7	34.9	6.52	13.45	11	4.6
15	58.2	6.56	14.12	12	4.6
21	68.4	18.21	26.4	15.4	4.96
28	82.5	23.99	35.29	17.1	5.2
34	87.9	37.81	41.73	19.3	5.2
40	94.66	41.75	58.01	22.81	5.2
47	98.55	—	—	22.95	5.52
55	102.53	—	—	26.94	5.6
61	107.27	—	—	27.88	10.67
69	114.88	—	—	29.91	10.9
90	120.14	—	—	32.25	42.65

*A.V., acid value expressed as milligram potassium hydroxide per gram rice oil., ** SRB, stabilized rice bran.

from 4.4 at zero-time to 10.67 and 42.65 after two and three months, respectively.Heating rice bran prevented enzyme hydrolysis by lowering the bran moisture content, (Nasirullah *et al.*,1989). The bran which was stabilized by extrusion at 130°C and 150 r.p.m showed no increase in acid value within seven days storage then increased from 5.8 at zero-time to 7.75 and 8.7 after 60 and 90 days, respectively. The extrusion at 130°C could effectively destroy the activity of lipase and produce shelf stable rice bran . In this respect, Saunders (1989) found that stabilization by extrusion at 130-140°C prevents rapid oil deterioration by lipase activity and limits bacterial growth.

Table(3):Effect of bran stabilization by extrusion at different temperature and rpm and storage at room temperature on acid values of rice bran oil.

Storage Period (in days)	Untreated *A.V.	Extrusion 110°C (*A.V.)		Extrusion 130°C (*A.V.)		Extrusion 150°C (*A.V.)	
		50 r.p.m.	150 r.p.m.	50 r.p.m.	150 r.p.m.	50 r.p.m.	150 r.p.m.
0	5.7	5.8	6.3	5.8	5.2	5.8	5.1
7	34.9	10.7	7.1	6.1	5.28	6.1	5.4
15	58.2	11.2	8.6	6.5	6.4	6.2	6.2
21	68.4	11.8	9.99	7.1	6.5	6.34	6.27
28	82.5	11.6	11.4	7.25	6.56	6.5	6.29
34	87.9	11.66	11.62	7.49	7.2	6.7	6.6
40	94.66	13.99	12.25	7.89	7.6	6.88	6.8
47	98.55	14.1	11.97	9.1	7.6	7.2	6.9
55	102.53	14.7	11.58	9.2	7.7	7.33	6.95
61	107.27	15.23	11.9	9.3	7.75	7.69	6.99
69	114.88	15.25	12.82	13.05	8.59	8.5	7.3
90	120.14	16.05	14.52	13.89	8.7	9.13	8.38

* A.V., Acid value expressed as milligram potassium hydroxide per gram rice oil.

3.3. Effect of stabilization techniques on fatty acid pattern

Fatty acids of heat, extrusion stabilized and untreated rice bran, were identified in oils. The results reported in Table (4) show that the major fatty acids were palmitic, oleic, and linoleic, which make up more than 90% of the total fatty acids in rice bran oil. Similar results were reported by Saunders (1990), who found out that the three major fatty acids palmitic, oleic and linoleic, composed up to more than 90% of the total fatty acids.

Heat stabilization of the oils led to an increase in palmitic and oleic but linoleic and linolenic acids decreased. Extrusion stabilization resulted in an increase in oleic and linoleic acid contents which led to an increase of unsaturated fatty acids.

Nasirullah *et al.,* (1989) also found a marginal difference in the quantity of individual fatty acids in oils of acid, heat and cold stabilized rice bran; palmitic, linoleic and oleic acids were found to be in the increasing order. The increase of linoleic acid compared to the control may be due to the bound lipids, which were released during the treatment and traveled into the oil during extraction.

Table(4): Relative percentages of fatty acids in rice bran oil after heat and extrusion stabilization compared with untreated control samples.

Acid	Untreated	Dry heating (130°C 15 min.)	Extrusion (130°C 15 min.)
Octanoic 8 : 0	0.98	0.8	0.031
Palmitic 16 : 0	16.55	23.15	15.996
Oleic 18 : 1	30.39	31.15	40.58
Linoleic 18 : 2	24.17	21.4	32.82
Linolenic 18 : 3	2.7	1.3	2.7

3.4. Effect of stabilization techniques on minerals pattern

Table (5) showed mineral contents of heat, extrusion stabilized and untreated rice bran. Rice bran has been found to be rich in calcium and potassium, also it is a good source of Fe, Cu, Zn, Mg, Mn, K, Na, Cu, P.It could be noticed that mineral contents were unaffected by the

Table(5):Mineral contents of heat and extrusion stabilized and untreated rice bran(p.p.m.).

Sample	Mg	Fe	Cu	Zn	K	Mn	Na	Ca	P
(untreated)	6100	199.1	14.86	43.52	11912.5	226.6	90.59	214.8	25650
Dry heating 130°C 15 min.	6050	195	14.09	36.15	14612.5	257	107.1	241.4	27690
Extrusion 130°C 150 r.p.m.	5900	204	16.86	40.16	12862.5	258.6	111.7	229.7	26800

heat and extrusion stabilization. Al-Jasser and Mustafa (1996) found similar results and reported that rice bran contained high amount of K, Ca, and Mg. and an appreciable amount of iron.

Table(6):Amino acid (A.A)composition of untreated and stabilized rice bran (g/100g.protein) compared with international standards.

Amino acid (A.A)	Untreated	Dry heating (at 130°C 15 min.)	Extrusion (at 30°C 150 r.p.m.)	Casein	FAO/who (1990)
Lysine(lys.)	5.78	4.01	4.35	6.99	5.5
Thereonine(Thr.)	4.15	3.66	3.02	3.72	4
Cysteine(cys.)	3.25	3.46	3.18	0.33	3.5
Methionine (Met.)	2.35	1.73	1.84	2.59	
Valine (Val.)	6.59	4.15	4.65	5.7	5
Isoleucine(ILe.)	3.97	2.83	3.1	4.46	4
Leucine (Leu.)	8.58	5.74	6.42	8.27	7
Tyrosine (Tyr.)	2.44	1.86	1.77	4.79	6
Phenylalanine (Phe.)	5.51	3.59	3.98	4.47	
Total essential A.A.	42.62	31.03	32.31	41.32	
Serine (Ser.)	4.88	4.01	3.1	5.03	
Proline (Pro.)	5.42	3.52	3.97	9.32	
Glycine (Gly.)	6.77	4.42	4.94	1.65	
Alanine (Ala.)	7.68	4.97	5.6	2.61	
Aspartic (Asp.	10.11	9.88	10.76	6.18	
Glutamic (Glu.)	18.07	9.67	14.08	9	
Histidine (His.)	3.71	2.28	2.66	2.65	
Arginine (Arg.)	8.77	7.81	6.93	3.22	
Total non essential A.A	56.64	46.56	52.04	39.66	

3.5.Effect of stabilization techniques on amino acid pattern

Amino acids of heat and extrusion stabilized in comparison with the untreated rice bran were determined and the results are reported in Table (6) as g/100g protein compared with casein and FAO/WHO Standards (1990). Rice bran is rich in essential amino acids as leucine, valine, lysine and phenylalanine which recorded 8.58,6.59,5.78 and 5.51%, respectively as compared with Casein which had 8.27, 5.7, 6.99 and 4.47%, respectively. Rice bran is rich in non-essential amino acids in particular, glutamic and aspartic acids. Heat and extrusion stabilization of rice bran decreased the amount of most amino acids. Barber and Benedito (1985) found that the level of available amino acids in the bran of parboiled rice was lower than in the bran of the parent rice. Loss of availability increased with severity of treatment.

In conclusion, stabilization of rice bran by extrusion technology at 130°C and 150 rpm gave a reasonably stable product which is granulated, fair in color and stable up to two months storage. Stabilization techniques had a minor effect on fatty acids and mineral content in comparison with untreated rice bran. Moreover, heat stabilization caused a slight decease in amino acid patterns of rice bran. Since the amino-groups of A.A. could be involved in chemical reaction of Millared-type with the aldhyde groups of carbohydrates present in rice bran, a decrease of most of amino acids occurred. However, stabilization of rice bran is a practical procedure to enhance the utilization of by-products of the rice milling industry.

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تأثير معاملات الثبات المختلفة على صفات الجودة لرجيع الكون

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ملخـــص

تشمل الدراسة تأثير كل من المعاملة بالحرارة والمعاملة بواسطة البثق الحرارى على صفات الجودة لرجيع الكون والزيت المستخلص منه. وقد وجد أن المعاملة بواسطة الحرارة الجافة على ١٣٠°م و١٥دقيقة ، والمعاملة بواسطة البثق الحرارى على ١٣٠°م و١٥٠ لفة / دقيقة أدت إلى انخفاض الرقم الحمضى إلى ٥,٦ ، ٧,٧ على التوالى بعد ٥٥ يوم وذلك بالمقارنة بالعينة غير المعاملة حيث كان الرقم الحمضى ١٠٢,٥٣ بعد ٥٥ يوم .

كان للمعاملة بواسطة البثق الحرارى على ١٣٠°م و١٥٠ لفة / الدقيقة تأثير فى تثبيط نشاط أنزيم الليبيز. وزيادة مدة صلاحية العينات حيث كان الرقم الحمضى ٨,٧ بعد ثلاث شهور .

وقد تم تقدير الأحماض الدهنية فى عينات رجيع الكون غير المعامل والمعامل بالحرارة والمعامل بالبثق الحرارى. وجـــد أن أكثر الأحمـــــاض الدهنية

الشائعة كانت البالميتك والأوليك واللينوليك حيث مثلت أكثر من ٩٠% من الأحماض الدهنية الكلية.

أظهرت المعاملة بالحرارة زيادة فى حامض البالميتك والأوليك بينما أنخفضت الأحماض الدهنية اللينوليك واللينولينيك وأظهرت المعاملة بالبثق الحرارى زيادة فى كل من حامض الأوليك واللينوليك.

تم تقدير العناصر المعدنية فى عينات رجيع الكون ووجد انه مصدر غنى فى عنصرى الفوسفور والبوتاسيوم كما يحتوى على نسب جيده من عناصر الحديد والنحاس والزنك والماغنسيوم والمنجنيز والصوديوم ولم يتاثر محتوى الرجيع من العناصر المعدنيه بدرجة محسوسة عند المعاملة بالحرارة والمعاملة بالبثق الحرارى.

وقد تم تقدير كل من الأحماض الأمينية الأساسية وغير الأساسية. وجد أن الأحماض الأمينية الشائعة فى رجيع الكون هى الليوسين ، الفالين ، بينما كانت احماض الليثين والفينيل الانين موجودة بكميات متوسطة و كان من أكثر الأحماض الأمينية غير الأساسية فى رجيع الكون الجلوتاميك والأسبارتيك . وادت المعاملة بالحرارة أو بالبثق الحرارى الى انخفاض نسبه معظم الأحماض الأمينية.

ولذلك فأنه يمكن القول أن معاملات الثبات لرجيع الكون هى من التقنيات التى يمكن إستخدامها للاستفاده من مخلفات صناعة ضرب الأرز.

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