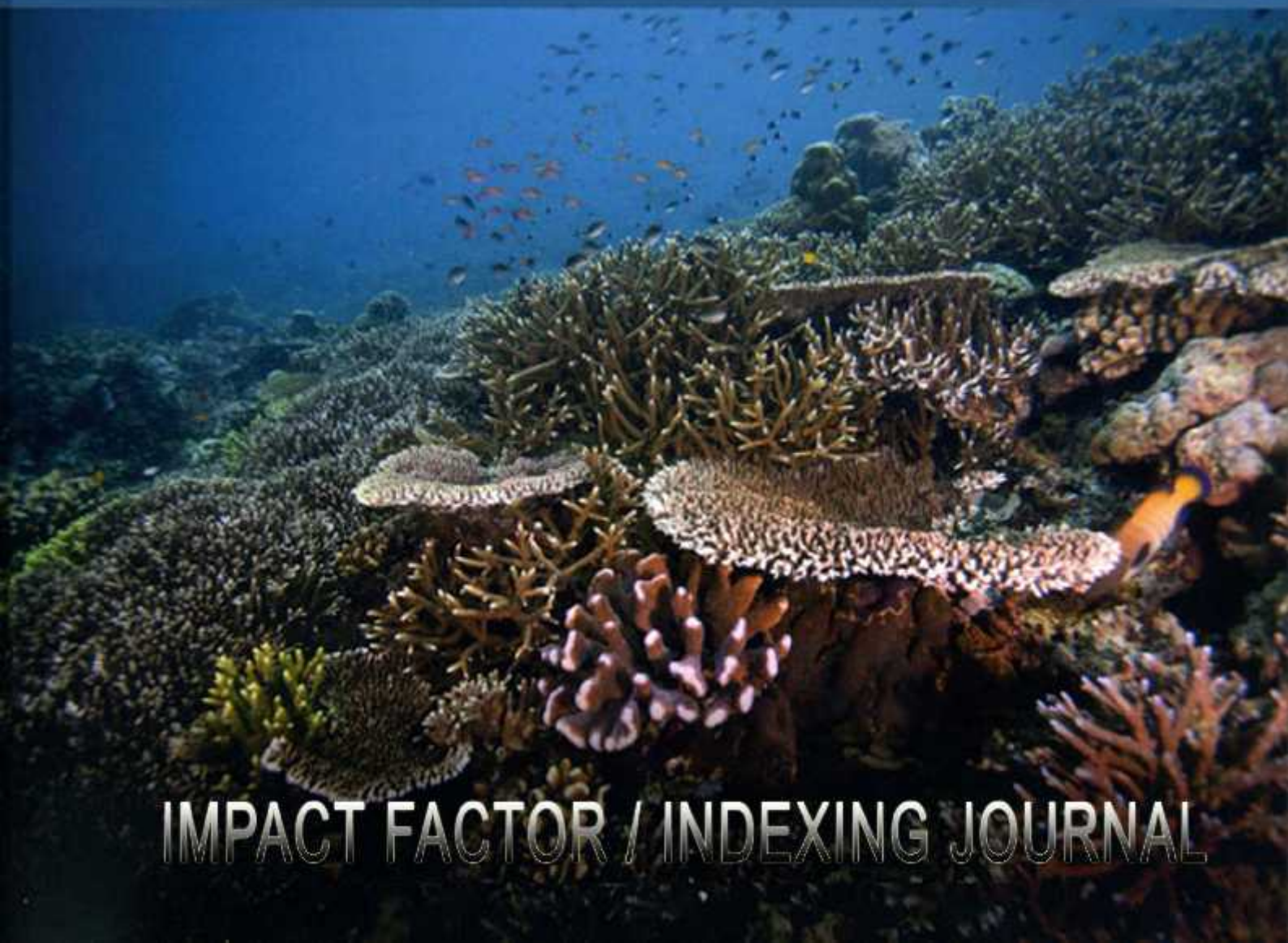
ISSN: 2230-9926

International Journal of Development Research

Vol.6, Issue 09, September - 2014



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Available online at http://www.journalijdr.com

International Journal of
DEVELOPMENT RESEARCH

ISSN: 2230-9926

International Journal of Development Research
Vol. 4, Issue, 9, pp. 1966-1969, September, 2014

Full Length Research Article

STUDIES TO DETERMINE THE EFFECT OF STORAGE ON EXTRUSION STABILIZED RAW AND PARBOILED RICE BRAN

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ARTICLE INFO

Article History:
Received 11th June, 2014
Received in revised form
22nd July, 2014
Accepted 07th August, 2014
Published online 30th September, 2014

Key words:
Lipase Activity,
Free Fatty Acids,
Crude Oil,
Extrusion,
Stabilization.

ABSTRACT

Rice mills are leading in one of its most significant by-product "rice Bran" mostly used for animal feeding. Now days it is gaining high level interest and attraction because of its nutritional value and potential applications in human diet. Rice bran preservation for safe use is still a challenge so this process is a big step towards stability of rice bran by heating immediately after milling. The major objective of this study was to determine the distinguishing features that enhance the quality of rice bran samples on commercial scale. Rice bran samples are exposed to heat treatment in order to promote its stability during storage under room temperature. For further verification different raw and parboiled rice bran samples were collected from various industries. All samples were evaluated for lipase enzyme activity during 60 days of storage. For this purpose an extrusion cooking procedure was adopted that leads to the production of stable rice bran showing no significant increase in free fatty acids (FFA) contents for minimum 60 days of storage. Extruded rice bran was in the form of small flakes or pallets containing 2-3 % moisture contents. During experimental storage extrusion heating method was proved efficient to enhance lipase inactivation by detecting free fatty acid value and crude oil contents.

INTRODUCTION

About more than 60% of world's population is based on rice as its major staple food. It is due the fact that it provides greater number of calories per hectare in comparison to any other crop (Khush, 2005). In India rice is extensively grown occupying an area of 36.95 million hectare with production and productivity of 110.5 million tons and 2.91 tons ha^{-1} respectively (Anonymous, 2010). Rice bran is a side product of rice milling that ranges from 8 to 10% of the whole grain. The total production of rice bran was approximately 0.8 million tons in the 2011-2012 in Pakistan which have 0.075 million tons of rice bran oil potential (Bassinello, 2004; Aboissa, 2012). The chemical configuration of the rice bran shows that it possesses certain characteristics with grain chemical compositions or with milling procedures. Rice bran is composed of huge amounts of proteins, lipids, edible fiber, minerals (magnesium, potassium, phosphorus, iron, manganese, and zinc), and vitamins (thiamin, riboflavin, niacin, pyridoxine, pantoteic acid, biotin, and tocopherol) (Carvalho and Bassinello, 2006; Hoffpauer, 2005). Many researches and studies have been directed regarding to work out its application in food because of its pivotal nourishing worth, low price and magnificent potential use in human nutrition (Douaud, 2007). Stabilized rice bran has a shelf life of about three months at certain temperatures less than 30°C. Its usage is mainly based for manufacturing breakfast cereals, snacks and extruded food products (Crowley and Halliday, 2008). Since it is similar to high fiber bread, it is used as a fortifying material for bakery products in purposeful diets (Abdul-hamid and Luan, 2000). It's playing role of a supplementary constituent in food industries (Kahlon, 2009). In Brazil, in addition to animal feed application rice bran serves as "Multi-Mixture" toasted flour and edible oil for malnourishing of children (Kahlon, 2009). Use of crude or untreated bran has factors that limit its use in human food, due to fast worsening or less stability during storage (Carvalho, 1995). During storage rice bran and its oil oxidation with significant enhancement in acidity and production of odor and rancid flavor takes place due to strong enzymatic activities of

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lipase, lipoxygenase and peroxidase enzymes (Glushenkova *et al*., 1998). And these are the main factors that reduce its uses for edible purposes (Aboissa, 2012). The storage conditions may be favorable for insects, fungi, and bacterial growth that may become a cause of depreciating grain quality and resultantly it may promote enzyme activation (Hoffpauer, 2005; Luh and Barber, 1991). On the other hand, high temperature may highlight the characters or features of enzymes, microorganisms, and protease natural (Luh and Barber, 1991; Malekian *et al*., 2000). Extrusion technology is a method that promotes enzyme inactivation and creates long product shelf life (rice bran) and the method is extensively used in USA for stability of rice bran (Carvalho and Bassinello, 2006; Randall *et al*., 1985). Rice parboiling is a hydrothermal process that involves the use of high temperature and pressure, and it results in less endosperm contamination of the bran, as the grain of the parboiling process is more abrasion and crack resistant. This is because the process of parboiling inactivates the enzymes responsible for lipid degradation of the rice bran and its oil contents (Saunders, 1990; Slavin and Lampe, 1992; Silva *et al*., 2006). The objective of this study was to assess lipase activity profile, and oil recovery %age of stored rice bran that is industrially processed & treated using heat processes.

MATERIALS AND METHODS

Commercially available rice bran samples were used in order to check their quality conditions about free fatty acids for direct human consumption. Rice industrial by-product i.e. raw rice bran and parboiled rice bran was obtained from different Rice Millsin Muridke and Kamoke.

Rice bran stabilization

The processing of rice bran was carried out immediately to inactivate endogenous lipases, responsible for fat deterioration. To achieve this objective, rice bran was subjected to extrusion stabilization technique.

Un-stabilized raw & parboiled rice bran

Rawrice bran without any stabilization treatment was collected from Amir Rice mills Kamoke. Ricebran obtained after soaking, steaming and drying before normal milling. Parboiled rice bran without any stabilization treatment was collected from Engro Eximp Muridke and evaluated the stability of both from 0 to 36 hours (Randall *et al.*, 1985).

Extrusion stabilized rice bran

Extrusion heating rice bran was prepared using a local made Extrusion Rice Bran Stabilizer with 80 Kg/hr production rate. The Raw and Parboiled was fed directly into the extruder with 12-13% moisture contents. The extruder is operated at 99-100ºC for 30 sec, held for 1 min at 99ºC to inactivate lipase and dried at hot air drier at 80^{o}C and cooled at room temperature (Randall *et al.*, 1985). The temperature of 100^{o}C is sufficient to inactivate the lipases completely in the raw as well as parboiled rice bran (Cheigh *et al*., 1984). At last the samples were then packed in food graded polyethylene bags to prevent moisture absorption (Kim *et al*., 1987).

Chemical changes in stabilized and un-stabilized rice bran samples were monitored by analyzing the samples for lipase activity, crude oil contents (0, 10, 20, 30, 40, 50 and 60 day's storage interval) and fatty acid profile analysis. The brief description of these methods is given below:

Crude oil content

The crude oil content of rice bran samples were determined by Soxhlet extraction method defined by Hong Qingci *et al*. (1993).

Lipase activity

Lipase activity was determined by estimating the amount of free fatty acids (FFA) in rice bran on monthly basis upto 2 months by alkalimetric titration (AOCS, 1998; AOAC, 2006). Increase in FFA (%) was taken as function of lipase activity in rice bran during storage.

Fatty acid profile analysis

Fatty acids need to be converted into fatty acid methyl esters (FAME) for GLC analysis (IUPAC, 1987).

Staistical Analysis: Analysis of variance of the data was computed using statistica computer program. The Least Significance test at 5% level of probability was used to test the differences among mean values (Steel *et al*., 1997).

RESULTS AND DISCUSSION

The present research project was planned to stabilize indigenous raw and parboiled rice bran (RB) for developing value added products that is edible rice bran oil. Raw and parboiled rice bran samples were stabilized by extrusion heating method to inactivate endogenous lipases; making stable against fat deterioration. Rice bran oil (RBO) was extracted from all bran samples and after refining, analyzed for fatty acid profile. The investigated parameters and their respective results are discussed below:

Fresh Un-stabilize draw and parboiled Rice Bran

Table 1 showed the results of fresh unstabilize draw rice bran oil. The data of raw rice bran showed the significant effect. The FFA% in raw rice bran at 0 hour is 3.76% and leads to 13% after 36 hours.

Table 1. Free Fatty Acids (FFA %) of Raw Un-stabilized Rice Bran during storage

Time Interval (Hours)	Free Fatty Acids (%) of Raw Rice Bran	Oil Percentage (%) of Raw Rice Bran
Freshly milled	3.76^{j}	15.25^{ab}
4	5^{i}	15.21^{ab}
8	5.96^{h}	15.23^{ab}
12	6.68^{g}	14.9^{abc}
16	9.87^{f}	14.87^{a}
20	10.1^{e}	14.73^{bc}
24	10.38^{d}	14.65^{c}
28	12.18^{c}	14.55^{c}
32	12.36^{b}	14.43^{c}
36	13^{a}	14.37^{c}

The recommended FFA% in rice bran is less than 10% but in this study after 36 hrs it goes to 13%. So the conclusion is that the raw rice bran must be stabilized within 20 hrs as data showed. The results of unstabilized parboiled rice bran shown in table 2. Parboiled rice bran showed good results in case of unstabilized form and after 36 hrs the amount of FFA% is 7.15% and this figure lies between the average recommended ranges of FFA%. All the data showed significant results.

Table 2. Free Fatty Acids (FFA %) of Parboiled Unstabilized Rice Bran during storage

Time Interval (Hours)	Free Fatty Acids (%) of Raw Rice Bran	Oil Percentage (%) of Raw Rice Bran
Freshly milled	3.1^{h}	16.75^{a}
4	3.21^{h}	16.56^{abc}
8	3.49^{g}	16.51^{bc}
12	5.26^{f}	16.43^{ab}
16	5.36^{f}	16.21^{abc}
20	5.58^{e}	16.13^{abc}
24	5.92^{d}	16.01^{bc}
28	6.32^{c}	15.58^{c}
32	6.88^{b}	15.56^{c}
36	7.15^{a}	15.48^{c}

Extrusion Stabilized Rice Bran

The amount of free fatty acids depends on the nature of fat or oil, method of extraction, storage conditions, humidity, temperature and lipase activity in rice bran. The free fatty acid (FFA) content of crude rice bran oil is relatively high, due to lipase activity in the bran (Nicolosi *et al*., 1991). The results of extrusion stabilized raw rice bran shown in table 3 and the parboiled rice bran shown in table 5. Extrusion conditions used for preparation of extruded raw and parboiled rice bran in this study effectively inactivated lipase enzyme. Both the above mentioned table showed the significant results. As we seen in table No. 3 of raw rice bran (Extruded) from 0 to 60 days of storage the value of FFA% increases from3.81 to 5.72 in T_1, 3.67 to 6.05 in T_2 and 3.6 to 5.79 in T_3 respectively.

Table 3. Free Fatty Acids (FFA %) of Raw Extrusion Stabilized Rice Bran during storage

Treatments		T1	T2	T3
Time/Temperature		100^{O}C for 1 min	100^{O}C for 2 min	110^{O}C for 1 min
Parameter		FFA%	FFA%	FFA%
Storage Days	0 DAY	3.81^{e}	3.67^{e}	3.6^{e}
	10 DAYS	4.1^{d}	3.81^{e}	4.1^{d}
	20 DAYS	4.23^{d}	4.19^{d}	4.51^{d}
	30 DAYS	4.42^{c}	4.38^{d}	4.62^{cd}
	40 DAYS	4.57^{b}	4.8^{c}	4.96^{bc}
	50 DAYS	4.69^{b}	5.45^{b}	5.12^{b}
	60 DAYS	5.72^{a}	6.05^{a}	5.79^{a}

Table 4. Oil Recovery % in Raw Extrusion Stabilized Rice Bran during storage

Treatments		T1	T2	T3
Time/Temperature		100^{O}C for 1 min	100^{O}C for 2 min	110^{O}C for 1 min
Parameter		OIL%	OIL%	OIL%
Storage Days	0 DAY	16.2^{a}	15.8^{a}	16.8^{a}
	10 DAYS	15.95^{a}	15.72^{a}	16.32^{b}
	20 DAYS	15.92^{a}	15.62^{a}	16.1^{bc}
	30 DAYS	15.9^{a}	15.6^{a}	15.85^{cd}
	40 DAYS	15.82^{a}	15.58^{a}	15.67^{d}
	50 DAYS	15.8^{a}	14.96^{b}	15.62^{de}
	60 DAYS	15.69^{a}	14.91^{b}	15.53^{e}

Table 5. Free Fatty Acids (FFA %) of Parboiled Extrusion Stabilized Rice Bran during storage

Treatments		T1	T2	T3
Time/Temperature		100^{O}C for 1 min	100^{O}C for 2 min	110^{O}C for 1 min
Parameter		FFA%	FFA%	FFA%
Storage Days	0 DAY	2.39^{d}	2.93^{e}	3.2^{c}
	10 DAYS	2.82^{c}	3.21^{d}	3.29^{bc}
	20 DAYS	2.82^{c}	3.35^{cd}	3.36^{b}
	30 DAYS	3.1^{b}	3.45^{bc}	3.39^{b}
	40 DAYS	3.38^{a}	3.53^{b}	4.09^{a}
	50 DAYS	3.42^{a}	3.73^{a}	4.12^{a}
	60 DAYS	3.48^{a}	3.86^{a}	4.17^{a}

Table 6. Oil Recovery % in Raw Extrusion Stabilized Rice Bran during storage

Treatments		T1	T2	T3
Time/Temperature		100^{O}C for 1 min	100^{O}C for 2 min	110^{O}C for 1 min
Parameter		Oil %	Oil %	Oil %
Storage Days	0 DAY	18.6^{a}	18.2^{a}	18^{a}
	10 DAYS	18.3^{ab}	17.7^{a}	17.92^{ab}
	20 DAYS	18.15^{bc}	16.8^{b}	17.88^{ab}
	30 DAYS	17.9^{cd}	16.8^{b}	17.78^{ab}
	40 DAYS	17.8^{d}	16.6^{bc}	17.35^{abc}
	50 DAYS	17.79^{d}	16.2^{bc}	17.17^{bc}
	60 DAYS	17.63^{d}	15.8^{c}	16.8^{c}

Table 7. Fatty Acid Profile Analysis regarding different treatments of Raw Rice Bran Oil

Fatty Acids (%)	Raw Rice Bran Oil		
	100°C/1 min	100°C/2 min	110°C/1 min
C 14:0	0.3941	0.3825	0.3366
C 16:0	25.7635	25.132	23.5265
C 18:0	1.4482	1.498	1.4846
C 18:1	44.9898	44.4573	44.7032
C 18:2	22.9536	24.4168	24.657
C 18:3	0.4522	0.5831	0.5879
C 20:0	0.5076	0.5909	0.7004
C 20:1	1.4033	1.1589	1.5974
C 22:0	0.7171	0.6925	0.6637

Table 8. Fatty Acid Profile Analysis regarding different treatments of Parboiled Rice Bran Oil

Fatty Acids (%)	Parboiled Rice Bran Oil		
	100°C/1 min	100°C/2 min	110°C/1 min
C 14:0	0.2533	0.3789	0.3104
C 16:0	21.065	24.644	21.3462
C 18:0	1.7379	1.5323	1.5453
C 18:1	46.2565	44.6563	43.7838
C 18:2	26.473	24.7154	28.39
C 18:3	0.6737	0.6001	0.7226
C 20:0	0.8271	0.5772	0.6764
C 20:1	1.1184	1.1622	1.2314
C 22:0	0.3214	0.6505	0.3015

C 14:0 Myristic Acid, C 16:0 Palmitic Acid, C 18:0 Stearic Acid, C 18:1 Oleic Acid, C 18:2 Linoleic Acid, C 18:3 Linolenic Acid, C 20:0 Arachidic Acid, C 20:1 Eicosanoic Acid, C 22:0 Behenic Acid.

While in case of extruded parboiled rice bran FFA% found in increasing trend from 2.39 to 3.48 in T_1, 2.93 to 3.86 in T_2 and 3.2 to 4.17 in T_3 respectively in 60 days each with 10 days interval. The above results showed that with every increase in the amount of free fatty acids the recovery of crude oil decreases. The higher oil contents obtained in treatment (100^{o}C for 1 min). In present study, oil extracted from unstabilized rice bran possessed high levels of free fatty acids as compared to oil extracted from stabilized rice bran samples

(Nicolosi *et al*., 1994). The results of raw and parboiled rice bran oil samples that were analyzed for fatty acid profile through gas chromatography (GC) presented in Table 7 and 8. The investigated oils were found to contain a high level of unsaturated fatty acids (C 18:1) 44.99% & 46.26% in raw and parboiled rice bran oil respectively. The contents of linoleic acid (C 18:2) in the bran oils were 22.95% & 28.39% while in Linolenic acid (C 18:3) were 0.59% &0.72% in raw and parboiled rice bran oil samples respectively. Rice bran oil has an excellent fatty acid profile. It has oleic acid (38.4%), linoleic acid (34.4%) and linolenic acid (2.2%) as unsaturated fatty acids while palmetic (21.5%) and stearic acid (2.9%) as saturated fatty acids (Rukmini and Raghuram, 1991).

Conclusions

The FFA and crude oil values obtained in this study showed that Extrusion heating method can be used as an excellent method for inactivation of lipase and ultimately extend the shelf life of rice bran upto 60 days of storage. With the extension of shelf life of rice bran, the recovery of oil contents from rice bran also increases.

Acknowledgment

We are thankful to the Punjab Agriculture Research Board (PARB) for a project "Exploration of Rice Bran Oil Production" to Rice Research Institute, Kala Shah Kaku, Lahore.

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