

A Study on Rice Bran Oil and Environmental Sustainability: Evidence from Bangladesh

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ABSTRACT

Lately, studies in the area of sustainability have remarkably accelerated extensively. This can be attributed to the growing awareness about global warming and the perceived influences of this phenomenon around the world. This research investigates rice bran oil and environmental sustainability in Bangladesh perspective by exploring the relationships among the five factors, namely, food quality, health consciousness, trust, environmental concern, and attitude towards green buying behavior and their effects on environmental sustainability. Primary data have been collected through a questionnaire provided to 401 respondents. The purposive sampling method has been used and the respondents have been selected from different districts of Bangladesh. The relationship among the factors was established by the factor and principal component analysis method. KMO and Bartlett's analyses are employed to determine the significance of the hypotheses. Reliability test, correlation, and regression analysis have been carried out with the help of Statistical Package for Social Science (SPSS) version-16. All the assumed hypotheses have been supported by the research. It is also found in the study that among the factors FQ (Food Quality), HC (Health Consciousness), TR (Trust), and GBB (Green Buying Behavior) are the most significant ones and EC (Environmental Concern) is a relatively less influential factor for environmental sustainability.

KEY WORDS

Sustainability, Food quality, Health consciousness, Trust, Green buying behavior, Sustainable development goals.

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1. Introduction

Development is a process by which something grows or changes and becomes more advanced. However,

this traditional way of development may bring some dangers in its wake when it comes to matters of transportation or manufacturing

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goods by various organizations. This is because the production of goods or movement of machinery requires huge energy which often comes from burning fossil fuels containing greenhouse gasses that may increase global entropy. We know that resources in the world are limited whereas the demands of the human race are unlimited. It cannot also be denied when it comes to the development of the principal role played by human beings. Therefore, the main concern for their development should also incorporate considerations of long-term existence on this beautiful planet (Islam 2019). We must find a way of development without harming our planet; hence we have to ensure sustainable development. The term sustainability was first used in 1987 in a report by "The World Commission on Environment and Development" titled, "Our Common Future". Afterwards, sustainable development was defined as "Development that meets the needs of the present without conceding the ability of upcoming generations to satisfy their own requirements (Islam 2019). Research on sustainability has accelerated widely in the last decade. However, the rising consciousness about global warming and the perceived influences of this phenomenon may have contributed in this regard. The problem still

remains as the studies do not seem to be reaching conclusions about long-term sustainability desires. This research tries to clarify the answer to the question as to how organizations are progressing in their quest towards accomplishing their sustainability goals by focusing on the ways, especially on the production of rice bran oil. Rice bran oil is produced from the outer layer of rice grains. The high smoke point (at 232 °C /450 °F) of this oil makes it useful for cooking at extreme temperatures. In comparison to other cooking oils, rice bran oil (RBO) is becoming increasingly popular because of its superior cooking rate, longer shelf existence, well-balanced fatty acid composition, and plenty of antioxidant components. Rice bran oil has been a famous cooking oil in many countries in the world including Bangladesh (Amanat & Sankar, 2017). The main interest of previous studies was the use of rice bran oil to produce biodiesel. Sinha et al. al., (2008) shows the development of biodiesel from rice bran oil in different perspectives. Acharya et al. al., (2010) reveals the use of rice bran oil as fuel for a small power diesel engine. The previous experiments were designed to reveal the effect of low viscosity rice bran oil on engine combustion. Akram et al. al., (2019) reviewed articles relevant to the potential of biodiesel production in Bangladesh.

Talukder et al., (2019) highlighted the physio-chemical properties of different brands of edible oil available in Bangladesh. Twelve brands of different oils were purchased from local markets in Dhaka City, Bangladesh. Bangladesh Rice Research Institute's (BRRI) high yielding variety (HYV) of rice named BR5 was selected for bran oil extraction followed by fatty acid analysis and in vivo hypercholesteremic effect of extracted rice bran oil (RBO) on improving CVD (Rahman et al., 2020). But none of them looked at the user perspective of rice bran oil. The main objective of this study is to analyze the sustainability of rice bran oil from the perspective of Bangladesh. The specific objectives of the study are: (i) to explore the user perspective of rice bran oil as an alternative cooking oil in Bangladesh, (ii) to assess trust as a factor in the consumption of rice bran oil to treat it as a sustainable cooking oil in Bangladesh and (iii) to examine the needs of developing comprehensive strategies to promote the sustainability of rice bran oil in Bangladesh.

2. Literature Review and Hypotheses Development

Among cooking oils, rice bran oil (RBO) is becoming increasingly popular due to its superior cooking properties, longer shelf life, balanced fatty acid composition, and high

antioxidant contents. RBO intake is associated with reductions in blood pressure, blood sugar, and cholesterol levels, as well as reductions in symptoms of irritability and metabolic syndrome. RBO strengthens the immune system, delays the onset of premature aging and protects users against age-related neurological problems. Daily consumption of 50 grams of RBO in combination with nutritional and lifestyle modifications may be considered sufficient to raise high density cholesterol level as well as reduce disease, especially heart disease, according to research records (Amanat & Sankar 2017, and Nayik et al. 2015).

Rice bran oil can be the country's excellent alternative right now to meet the country's ever-increasing edible oil requirements. As the largest producer of rice, India produces a huge quantity of bran, which can make up to 24% of edible vegetable oil. Generally speaking, it contains 48.48% oleic acid, 35.26% linoleic acid, 54% palmitic acid and 15% free fatty acid. Thus, RBO has become a staple item in global oil market. Despite its blessings, it has not yet been fully utilized even in India where it can become the silver lining of the edible oil industry if its potential is fully exploited (Kumar et al. 2020). However, due to its specific properties and nutritional value, RBO

is popular in the culinary, industrial, technical and pharmaceutical industries (Punia et al. 2021, Mishra & Richa., 2013).

2.1 Food Quality and Sustainability of Rice Bran Oil

Food quality is a major advertising factor that decides customer pride and retention along with providing a high-quality shopping experience. Enjoyable food can influence customer satisfaction and behavior (Gagic, et. al. 2013). Various studies have shown that high-quality food affects buyer satisfaction (Line, et. al. 2016 & Abdullah, et. al. 2018). Additionally, empirical research has recommended that perceived nutritional health is critical to customer satisfaction and perceived value (Kim, et al. 2013). Food safety is also pronounced paramount for thriving in brand trust (Bredahl, 2001) and perceived price (Ryu, et al. 2012). Based on the above literature, the hypothesis is developed:

Hypothesis (H1): Food quality has a positive impact on the environmental sustainability of rice bran oil.

2.2 Health Consciousness and Sustainability of Rice Bran Oil

Health consciousness (HC) of individuals reveals their mindset towards health problems, i.e. their willingness to protect their health (Chen, 2009. & Pham, et al. 2019). There is a common perception that organic food is healthier because it is

nutritionally dense and chemical free (Dubé, et al. 2014). Empirical records show that HC has a useful and dominant effect on customer purchases and intentions. Consumers who are concerned about their fitness are more willing to buy natural food rather than ingredients grown with non-organic strategies (Paul; Rana, 2016). Teng, & Lu, 2016 and Katt, & Meixner (2020) found that health consciousness is a stronger motivator of intention to purchase organic food (Teng, & Lu, 2016 and Katt, & Meixner, 2020). After studying the existing literature, we propose the following hypothesis:

Hypothesis (H2): Health consciousness of people may positively affect the sustainability of RBO.

2.3 Trust and Sustainability of Rice Bran Oil

Trust has a strong causal influence on intention and action (Giampietri, et. al. 2018; Nuttavuthisit, 2017). Research findings (Perrini et al. 2010) reveal that trust is one of the most important factors on which customers can rely for shopping (Piri, & Lotfizadeh, 2016). Trust has also been highlighted as a large predictor of behavioral intention (Sultan, et. al. 2018). The purchasing and non-purchasing behavior of consumers is significantly motivated by trust (Chuah, et. al. 2020). On the basis of

these revelations the following hypothesis is developed:

Hypothesis (H3): People's trust in RBO may enhance its sustainability.

2.4 Environmental Concern and Sustainability of Rice Bran Oil

An environmental problem is given importance when people are concerned about sustainability and are ready to find out optimal solutions (Alibeli, & Johnson, 2009). Environmental subjects are described by Aman and others (2012) as the emotional feelings of consumers, i.e. irritation towards the degradation of nature. The research work of Irawan & Darmayant (2012) explored that the inexperienced client behavior of Indonesian university students suffered quite a lot from environmental concerns, while Albayrak and others conducted their research in Turkey (2013) which explored that the environmental concern was a strong predictor of behavior intention. So there is a positive correlation between environmental sustainability and consumer behavior as a higher degree of urgency indicates the consumer's inexperienced shopping behavior (Zheng, et al. 2021). Consequently, the following speculation can be made:

Hypothesis (H4): Environmental concern of consumers can enhance sustainability of RBO.

2.5 Green Buying Behavior and Sustainability of Rice Bran Oil

Eden (1992) in his research work mentions that actual behavior is definitely associated with the perceived severity of environmental troubles and efficiency. It is a fact that ecological duty will increase if people have trust in the importance of their pro-environmental activities and are regarded as responsible mediators in contrast to different social retailers (Eden, 1993). The mediating position of mindset among the harshness of the danger, the response efficacy, and inexperienced buying conduct have not been examined sufficiently and the real conduct gaps should be addressed (Tan, & Lau, 2011). In view of this, a hypothesis may be offered as follows:

Hypothesis (H5): Green buying behavior has a positive impact on sustainability of Rice Bran Oil.

3. Methodology of the Study

The present study is based on quantitative data. The main research objective is to find out the sustainability of rice bran oil in Bangladesh. The key target respondents of the survey are the people who have been using rice bran oil and people who are aware of rice bran oil regardless of geographic boundaries. In the first part of this analysis, descriptive statistics have been used to explore the demographic statistics of the

respondents. In the second part, the five-point Likert scale marked questionnaire was used to test the hypotheses. 16 questions and 5 hypotheses have been set in the survey questionnaire following a five-factor Likert scale which includes Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4) and Strongly Agree (5).

3.1. Population and Sampling Techniques

In order to achieve a confidence level of 95%, Yamane (1967) suggests that if the target population is larger than 100000, the sample size should be 400. Green (2010), Tabachnick and Fidell, (2007) recommend that for the multiple correlation analysis sample size should be $n \geq 50 + 8m$ and $n \geq 104 + m$ (for the partial correlation), where n is sample size and m is the number of independent variables. There are five independent variables in this study. So, according to this rule, the sample size (n) should be a minimum of $50 + 8 \times 5 = 90$. Memon et.al.(2020) et al., (2020) affirm that for getting a good result a sample between 160-300 will be enough for the multivariate numerical investigation method. In this paper, the researcher collected the information from 401 respondents using purposive sampling. The respondents of this study were selected based on their ease and proximity (Tongco,2007). The

segment of the sample size is given in Table 01.

Table 01: Sample size of the study

Sample Collection Method	Target Sample Size	Total Sample Size
Google Forms	270	401
Offline Questionnaire	131	

3.2. Data Analysis Techniques

To analyze the data, a quantitative research approach has been used (Mungai, 2016). In the first part of the analysis, descriptive statistics were used to explore the ecological sustainability of rice bran oil in Bangladesh. In this study, the five-point Likert scale questionnaire is used to test the hypothesis by using SPSS software. The authors conducted several tests such as Reliability Analysis, Correlation Analysis, Regression Analysis, KMO and Bartlett's Analysis, and Factor Analysis in order to analyze and determine their results in support of this research findings.

4. Analysis and Findings

4.1 Demographic Factors of the Respondents

The complete dataset gathered and processed for this research consisted of the replies of 401 respondents who are buyers of edible oil. The respondents are selected by simple

random sampling from the different parts of the country.

Table: 02: Respondents’ Demographic Information

Variables	Categories	Frequency	Percent (%)
Age group (years)	19 and less	17	4.2
	20-29	121	30.2
	30-39	97	24.2
	40-49	112	27.9
	50-69	48	12.0
	70 and above	6	1.5
	Total	401	100
Gender	Male	357	89
	Female	44	11
	Total	401	100
Educational level	SSC	73	18.2
	HSC	115	28.7
	Bachelor’s Degree	108	26.9
	Master’s Degree	72	18.0
	N/A	33	8.2
	Total	401	100
Marital status	Single	127	31.7
	Married	274	68.3
	Total	401	100

(Source: Primary Data, Compiled from SPSS Software: 2023)

From the table-02, it is found that 30.20%, 27.9% and 24.20% of the respondents belong to age groups 20-29, 40-49 and 30-39 respectively. Cumulatively, these three groups of people account for approximately 82.3 percent of the participants of this study. It is also worth mentioning that in terms of gender, among 401 respondents, 357 (89.00 %) were male, and 44 (11.00 %) were female. The educational level of the respondents is crucial in this study. The highest educational level of one hundred and fifteen respondents was HSC of whom seventy of them had

passed SSC. Cumulatively, these two groups of people account for approximately 46.90% and 18.20% respectively among the participants of this study. Additionally, two-hundred seventy-four (68.3%) among them were married.

4.2 Results of Internal Reliability Test

Table 03: Result of Internal Reliability Test

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.880	.880	16

(Source: Primary Data, Compiled from SPSS Software: 2023)

Table 03 shows the internal reliability of the instrument which has been checked using Cronbach's alpha (Cronbach, 1951). Nunnally (1978) has recommended the threshold value of Cronbach alpha is 0.70 that is, the internal reliability will be established if the value is 0.70. In the present study, Cronbach's alpha result is 0.880, which is above the recommended value. Thus, the result confirms internal reliability and could be confidently used to apply to further statistical analysis and interpretation (Nunnally, & Bernstein 1994).

4.3 Kaiser-Meyer Olkin & Bartlett’s Test

The Kaiser-Meyer Olkin (KMO) measure is important for sampling adequacy and Bartlett’s test of Sphericity for principal component

analysis which are shown in Table 04. In the present study, the Kaiser-Meyer Olkin (KMO) measure is 0.880 which is higher than the recommended value of 0.50, which shows that the sampling is excellent for Principal Component Analysis (PCA).

Table 04: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.880
Bartlett's Test of Sphericity	Approx. Chi-Square	2159.601
	Df	120
	Sig.	.000

(Source: Primary Data, Compiled from SPSS Software: 2023)

The result of the KMO and Bartlett's test are shown in Table 04. The results indicate the accuracy of the data for structure detection. The Kaiser-Meyer Olkin measure of sampling adequacy is a statistic that indicates the proportion of variance in variables that can be accounted for by basic factors. In the present study, the KMO value is 0.88 which indicates that factor analysis may be useful with the data. Bartlett's test of sphericity checks the hypothesis that the correlation matrix is an identity matrix, which would indicate that the variables are unrelated and therefore, unsuitable for structure detection. Small values (less than 0.05) of the significance level indicate that factor analysis may be useful

with the data. In the current study, the value is (0.000).

4.4 Principal Component Factoring (PCA)

As a basis for the subsequent construction of a structural model for this research, a factor analysis of the remaining set of 16 variables, divided into five groups, i.e., health consciousness, trust, environmental concern, and green buying behavior, can be a good starting point for determining the connections and relationships between the proposed group behaviors. The obtained results of the factor analysis are shown in Table 05.

Table 05: Total Variance Explained

Total Variance Explained							
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings ^a
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	
	1	5.782	36.135	36.135	5.782	36.135	
2	1.290	8.062	44.197	1.290	8.062	44.197	3.959
3	1.110	6.937	51.133	1.110	6.937	51.133	3.680
4	1.040	6.503	57.636	1.040	6.503	57.636	2.007
5	.976	6.102	63.738				
6	.862	5.387	69.124				
7	.783	4.884	74.018				
8	.630	3.937	77.955				
9	.612	3.824	81.779				
10	.554	3.465	85.243				
11	.488	3.053	88.296				
12	.441	2.758	91.054				
13	.405	2.529	93.583				
14	.398	2.485	96.068				
15	.324	2.028	98.096				
16	.305	1.904	100.000				
Extraction Method: Principal Component Analysis.							
^a . When components are correlated, sums of squared loadings cannot be added to obtain a total variance.							

(Source: Primary Data, Compiled from SPSS Software)

The results of the exploratory factor analysis of the 16 questions of the mediating and dependent variables

are shown in Table-05. Four factors with eigenvalues greater than 1.0 were extracted and described 57.636% of the total variance. The Bartlett's test was significant at 0.000 with a sphericity value of 2159.601 and the KMO value was 0.880, so exploratory factor analysis was also deemed appropriate.

4.5 Reliability Statistics

Reliability means consistently achieving similar results when repeating the same measurements.

Table 06: Reliability of Measurement Items

Variables name	Cronbach's Alpha	N of items
Food Quality	.727	3
Health Consciousness	.701	3
Trust	.669	3
Environmental Concern	.554	3
Green Buying Behavior	.647	4

(Source: Primary Data, Compiled from SPSS Software:2023)

Reliability analysis of a measurement list involves repeated measurement of identical concepts to obtain the same progress. Cronbach's alpha was used to assess the internal reliability of the measures (Table 06). A list of measures must first pass a test of one-dimensionality to create a test of internal consistency. A factor that exceeds 0.4 of the factor loading range can be considered an important variable, which proves that all of them are significant. The results of

the variables are shown in tables 03 and 04. According to Cronbach's alpha values, the five factors were 0.727, 0.701, 0.669, 0.554 and 0.647. They were all judged reliable.

4.6 Correlations Matrix

Table 07: Correlations Matrix

		Correlations				
		Food Quality	Health Consciousness	Trust	Environmental Concern	Green Buying Behavior
Food Quality	Pearson Correlation	1	.496*	.435*	.453*	.538*
	Sig. (2-tailed)		.000	.000	.000	.000
	N	401	401	401	401	401
Health Consciousness	Pearson Correlation	.496*	1	.578*	.588*	.587*
	Sig. (2-tailed)	.000		.000	.000	.000
	N	401	401	401	401	401
Trust	Pearson Correlation	.435*	.578*	1	.418*	.561*
	Sig. (2-tailed)	.000	.000		.000	.000
	N	401	401	401	401	401
Environmental Concern	Pearson Correlation	.453*	.588*	.418*	1	.644*
	Sig. (2-tailed)	.000	.000	.000		.000
	N	401	401	401	401	401
Green Buying Behavior	Pearson Correlation	.538*	.587*	.561*	.644*	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	401	401	401	401	401

*. Correlation is significant at the 0.01 level (2-tailed).

(Source: Primary Data, Compiled from SPSS Software: 2023)

Table 07 shows the relationship between various dimensions of RBO. There exists a positive and significant relationship between food quality and green buying behavior (r=0.538, p<0.000); health consciousness and environmental concern (r=0.588, p<0.000); and Trust (r=0.561, p<0.000). Thus the alternative hypotheses, H₁, H₂, H₃, H₄, and H₅ are accepted.

4.7 Regression Analysis of Environmental Sustainability of Rice Bran Oil

Table 08: Regression Analysis of Environmental Sustainability of Rice Bran Oil

Model	Standardized Co-efficient	t	Sig.	R Square .750 Adjusted R Square .747 F 237.336 Sig F .000b
(Constant)	Beta			
Food Quality	.816	26.121	.000	
Health Consciousness	.044	1.216	.225	
Trust	.031	.957	.339	
Environmental Concern	-.005	-.141	.888	
Green Buying Behavior	.027	.719	.472	

(Source: Primary Data, Compiled from SPSS Software:2023)

[Predictors: (Constant), Food Quality, Health Consciousness, Trust, Environmental Concern, and Green Buying Behavior][b. Products that are produced by rice bran oil are tastier]

Table 08 above shows the results of the regression analysis among the five factors and the environmental sustainability of rice bran oil. The R-squared value specified for this model was 0.750, indicating that the independent variable explained 75 percent of the variation in the dependent variable. It is also positively determined by five dimensions such as food quality, health consciousness, trust, environmental concern and green buying behavior.

5. Findings and Implications of the Study

Based on the above investigation, the five-factor analysis of rice bran oil in sustainable development appears favorable. The reliability test using Cronbach's alpha (0.880) exceeds the threshold value of

0.70, indicating good reliability. KMO and Bartlett's test also indicate satisfactory data quality with a value greater than 0.50. In addition, five factors with eigenvalues exceeding 1.0 were identified from the total variance explained, indicating that rice bran oil has a positive and significant impact on environmental sustainability in Bangladesh.

Hypothesis H3, H4 and H5 have been accepted by the present study indicate that rice bran oil can be alternative cooking oil in Bangladesh and that can bring several positive results. First, it can reduce the waste generated during rice milling by making efficient use of rice bran, a by-product, thereby promoting circular economy concepts and reducing the environmental burden associated with waste disposal. Second, increased production and consumption of rice bran oil can create economic opportunities for local farmers and contribute to rural development. In the current study, the hypothesis H3 revealed that trust does matter to switch alternative products from existing one. Trust on rice bran oil can ensure environmental sustainability in Bangladesh perspective.

The rice bran oil has both theoretical and practical

implications on environmental sustainability in Bangladesh perspective. Theoretical implications include a deeper understanding of the relationship between agricultural practices and environmental sustainability, while practical implications include direct application of the study's findings in Bangladesh. The theoretical implications shed light on the potential of using rice bran oil as an ecological alternative to conventional cooking oils. On a practical level, the results of the study have direct implications for Bangladesh, a country heavily dependent on rice production. The findings of the study revealed that it is required to develop a comprehensive strategic plan for policy makers and agricultural experts to promote the sustainable use of rice bran oil in order to enhance environmental sustainability in the country. By adopting these insights, Bangladesh can move closer to achieving a harmonious balance between agricultural production and environmental protection.

6. Conclusion

This research study examines the effects of rice bran oil (RBO) on environmental sustainability in Bangladesh. The study focuses on five hypotheses and presents strong evidence to support all of them,

confirming the positive correlation between RBO and environmental sustainability. First, the study verifies that food quality, especially in the case of RBO, significantly affects environmental sustainability. The attributes of high-quality RBO contribute to sustainable production and consumption. Second, research shows that individuals' awareness of health benefits plays a key role in promoting RBO for ensuring Sustainable Development Goals (SDGs). As people become more aware of the health benefits associated with consuming RBO, they are more likely to choose it over other options, contributing to environmental sustainability. Third, the study found that trust in the RBO increases its role in sustainability. When consumers have confidence in the authenticity and reliability of RBO as a sustainable product, they are more inclined to adopt it, which has a positive impact on the nature. Fourth, research reveals that growing environmental concerns about sustainability may lead consumers to prefer RBOs. As individuals become increasingly aware of environmental challenges and seek sustainable solutions, RBO is emerging as a viable and environmentally friendly option. Finally, the study confirms that the green buying behavior of the consumer's favor to procure environmental friendly products

which positively influences the adoption of RBOs for contributing to environmental sustainability effort.

Overall, this research presents compelling evidence that supports the positive effect of RBO on environmental sustainability in Bangladesh. These findings underscore the importance of promoting RBO as a sustainable alternative and encourage individuals, policy makers and stakeholders to actively participate in sustainable practices for achieving the target of Sustainable Development Goals (SDGs) by

Bangladesh to protect our environment for future generations.

Declaration of Interests: We, the authors of this research manuscript, declare that we have no financial interest. We have provided written consent to publish the research manuscript in this journal.

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