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DEVELOPMENT OF FLATTENED RICE FLAKES AS VALUE ADDED SNACKS USING DEHYDRATED SPICES POWDER AS NATURAL PRESERVATIVES

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Abstract: Flattened rice defines as dehusked boiled rice which flattened into flat form flakes. Thicknesses of these flakes varied almost translucently thin near to four times thicker than normal rice kernel. The sample developed by dusting of dehydrated refined spice mixes of bay leaf, zinger, and garlic powder. Phytochemical component of spices having anti-oxidative properties works as natural preservative for cereal products. Proximate values of zinger, garlic, bay leaves and flattened rice were moisture, fat, protein, carbohydrate, energy and fiber contents (%) ranged from 5-8g, 2-8g, 7-16.5g, 54-81g, 316-356 Kcal and 3-26.3g, respectively. 1% (w/v) spices powder mix were incorporated as natural preservative into flattened rice designed as one control (S₁) and four treatments S₂, S₃, S₄ and S₅ samples. Physical properties of the samples were water activity (aₜ) and texture, resulted as S₄ of 0.201 to 0.223 & 5.342 to 5.122 and S₅ of 0.298 to 0.342 & 4.196 to 3.853. Moisture content and microbiological count for S₁ and S₀ were 8 to 8.2% & 13 to 15%; 40 to 42 & 40 to 80 cfug. The results are the indicator for crispiness and prolonged shelf life of developed snacks (S₅). Sensory evaluation (N=30) judged natural spices powder mixed flattened rice snacks (S₅) as significantly (P<0.01) superior for appearance, flavor, taste and overall acceptability than other treatment group.

Keywords: Flattened rice, Shelf life, Natural preservatives, Sensory, Anti-oxidant

Introduction

Rice (Oryza sativa) is a semi-aquatic, annual grass which can be grown under tropical or subtropical condition. It is one of the leading food crop and the major staple food for 60% of the world’s population. Rice is a rich source of bioactive compounds, which include – oryzanol (steryl ferulates) and Aminobutyric acid (GABA). Oryzanol esterifies transferulic acid and sterols or triterpenols is well known as the main bioactive compound in rice. Flattened rice is dehusked rice which is flattened into flat light dry flakes. These flakes of rice swell when added to liquid, whether hot or cold, as they absorb water, milk or any other liquids. The thicknesses of these flakes vary between almost translucently thin to nearly four times thicker than a normal rice grain. This is most popular snacks item among Asian region as every days menu if they intake. Flattened rice can be eaten raw by immersing it in plain water or milk with salt and sugar to taste, or lightly fried in oil with nuts, raisins, cardamoms, and other spices. The lightly fried variety is a standard breakfast in every corner of Bangladesh. It can be reconstituted with hot water to make a porridge or paste, depending on the

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proportion of water added. In villages, particularly in urban area in Bangladesh, flattened rice is also eaten raw by mixing with Molasses.

Snacks foods have been known in the world from time immemorial. Essential vitamins, minerals and other nutrients can only be gained from food. All over the world cereals are used as staple food for energy sources. Snacks cereals are defined as "processed grain formulations suitable for human consumption without further cooking" or ready to eating. Flattened Rice is the most available cereal snacks used all over the country round the year. It is locally known by many names viz. Chira or rice flakes. This is prepared from soaked paddy and has been claimed as a good source of fiber, carbohydrate, minerals and protein. Using some selected dehydrated spices such as Zinger, garlic, bay leaves and calcium carbonate as binder in the preparation of ready-to-eat snacks a way of value addition to this cereal grain. Availability of these spices, cheap and can be mixed with any other food items without any side effects. Newly, developed spices as preservatives not only enhance the taste and flavor of foods, but also increase the shelf life by being antimicrobial and antifungal effect with crispiness.

Zinger has a higher antioxidant activity which is similar to tertiary butyl hydroquinone (TBHQ), butylated hydroxyanisole (BHA), and butylated hydroxytoluene (BHT). The phytochemical constituents of spices plants such as garlic, ginger, bay leaf, onion etc have longed been known and their antimicrobial properties have been widely studied. Spices extract exhibited high but varied antifungal activity and can be used in controlling infection, preventing cold meat spoilage and preserve meat for longer periods against fungal contamination. Different extractive techniques correspond to different antimicrobial (antifungal) effectiveness. Bay leaves possess anti-spasmodic, antifungal, antibacterial and carminative agents. It is useful in treating gastroenteritis, chronic fatigue, poor circulation, rheumatism, diarrhea, menstrual problems, and leucorrhea. Different spices are effective for preservation of cereal or grain and beneficial for human health as it contains significant amount of phytonutrients, vitamins, and fiber that may protect degenerative diseases and also malnutrition deficiency diseases. Many valuable medicinal herbs or spices are becoming rare and precious information regarding their health benefits is lost due to lack of knowledge among consumers. Therefore, substitution of herbs in the preparation of flattened rice snakes will increase the nutrition value and also provide health benefits to consumers with low cost ready-to-eat snacks. Several spices, herbs and fruits contain volatile anti-microbial compounds. The objectives of this study was to develop ready-to-eat low cost, tasty and nutritious snacks of flattened Rice by incorporating edible spices powder mix as natural preservatives for long shelf life, along with a view to determine the product acceptability.

Materials and methods

Raw rice flakes were collected from Tongi bazzar, bay leaf, Zinger and CaCO₃ powder etc were arranged and procured from Dhaka, Bangladesh.

Processing of fattened rice snacks

Flattened rice snakes were prepared by mixing dehydrated spices powder 1% ratio then dried at 78°C for 20 min using rotary drum drier. Moisture content of the end product was 8% and then it was cooled and stored in an air tight pouch.

i. Collection of spices as natural preservatives

Zinger, garlic, and bay leaves powder was collected from local market of Bangladesh. The selected dehydrated spices were cleaned, shortened, pulverized and deodorized (tray drier) for chemical analysis. Stabilizer (CaCO₃) was used with spices powder mix as natural preservative.
ii. Chemical analysis

Moisture, protein, fat, and crude fiber content of selected dehydrated spices and flattened rice were analyzed in central lab of Prime Agro Foods Ltd, Dhaka and Dept of Nutrition and Food Engineering, Daffodil International University. Total carbohydrate content was determined by difference method, protein by Micro-kjeldhal method, fat by Soxhlet extraction method using petroleum ether (B.P. 60-70°C), and crude fiber according to AOAC17.

iii. Design of formulated snacks

1% dehydrated spices viz. zinger (Zingiber officinale), garlic (Ocimum basilicum), and bay leaves (Laurus nobilis), were dusted (or grinded) in four treatments $S_1$, $S_2$, $S_3$, and $S_4$, respectively along with CaCO$_3$ powder and control ($S_0$). The four treatments were tried several times and evaluated by the sensory methods. All treatments were then used for shelf life study.

Determination of Physical characteristics

i. Bulk density

The bulk density ($P_b$) was determined using the diameter and thickness with a digital micrometer. True density ($P_t$) was determined using an AccPyc II 1340 gas pycnometer (Micromeritics Instrument Co., Norcross, GA) at 20°C. Samples of each snack were dried at room temperature for 15 hr at 0% relative humidity in vacuum desiccators with anhydrous calcium sulfate (W. A. Hammond Drierite, Xenia, OH). After drying, samples were compressed into a measuring cylinder for true density measurements. Where, $P_t =$ true density; $P_b =$ bulk density.

ii. Water Activity

Water activity ($a_w$) was measured at 30 °C using an Aqua Lab dew point water activity meter 4TE (Decagon Devices, Inc., Pullman, WA).

iii. Texture

Compression tests were done on 5.5 mm diameter flat snacks mounted between two 1.5×1.5 mm square, ¾ in thick, iron plates with 1 mm diameter centered holes and puncturing over smooth and sound snack surfaces with $1.14 \pm 0.17$ mm thickness with a flat 1 mm diameter cylindrical probe attached to a TA-XT2i Texture Analyzer (Texture Technologies Corp., Scarsdale, NY) set at 0.1 mm/s test speed and 0.2 mm rupture test distance. Analysis was done at 25°C and plastic bags were used after opening of vacuum sealed for packaging the snacks. Number of cracks, force needed for first crack, first crack area, maximum force and maximum force area were obtained by 5 replicates for each snacks sample. Gram force (gf) values were converted into Newton’s (N); (1 Newton [N] = 101.971621297793 gf)

iv. Statistical Analysis

Data were analyzed with Minitab statistical software (version-5, Vassar Stats) by One-way analysis of variance and multiple comparison tests with ($P <0.01$) as criteria of significance.
Table 1: Recipe for formulated flattened rice snacks

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bay Leaves powder +CaCO₃ + Flattened Rice</td>
<td>0</td>
<td>1%+7%+92% =100%</td>
<td>0</td>
<td>0</td>
<td>1%+0+0 =1%</td>
</tr>
<tr>
<td>2</td>
<td>Garlic powder+CaCO₃ + Flattened Rice</td>
<td>0</td>
<td>0</td>
<td>1%+7%+92% =100%</td>
<td>0</td>
<td>1%+0+0 =1%</td>
</tr>
<tr>
<td>3</td>
<td>Zinger powder +CaCO₃ + Flattened Rice</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1%+7%+92% =100%</td>
<td>1%+7%+0 =8%</td>
</tr>
<tr>
<td>4</td>
<td>Spices mix (10%) + Flattened Rice</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1%+99% =100%</td>
</tr>
</tbody>
</table>

(In the spices, CaCO₃ has used as free flow agent and stabilizer of natural spices mix preservative)

In table 1, the formulated ingredients are shown as per designed. 1. Control (S₀): Control S₀ was prepared without incorporating spices mix (100% flattened rice), 2. Treatment S₁: It consists of 1% Bay leaves, and 99% flattened rice, 3. Treatment S₂: It consists of 1% Zinger and 99% flattened rice, 4. Treatment S₃: It consists of 1% Garlic and 99% flattened rice, and 5. Treatment S₄: It consists of 1% selected spices mix (1% bay leaves, 1% zinger, 1% garlic and 7% CaCO₃) and 99% flattened rice.

Results and Discussions

Table 2 showed the nutritional composition of the three selected dehydrated spices namely bay leaves (Laurus nobilis), zinger (Zingiber officinale), and Garlic (Allium longicuspis) and rice ingredient. Results showed that moisture, fat, protein, carbohydrate, energy and fiber contents (%) ranged from 5 to 8g, 2 to 8g, 7 to 16.5g, 54 to 81, 316 to 356 Kcal and 1.8 to 26.3g respectively.

Table 2: Proximate values of ingredients rice dehydrated spices and flattened rice snacks of all

<table>
<thead>
<tr>
<th>SL No</th>
<th>Local Name</th>
<th>Botanical Name</th>
<th>Moisture (%±SD)</th>
<th>Fat (%±SD)</th>
<th>Protein (%±SD)</th>
<th>Fiber (%±SD)</th>
<th>Carbohydrate (%±SD)</th>
<th>Energy, Kcal /100 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rice</td>
<td>Oryza sativa</td>
<td>13±1.2</td>
<td>2±0.34</td>
<td>7±1.75</td>
<td>1.8±0.38</td>
<td>76±5.76</td>
<td>350±10.49</td>
</tr>
<tr>
<td>2</td>
<td>Bay leaves powder</td>
<td>Laurus nobilis</td>
<td>5±0.76</td>
<td>8±1.13</td>
<td>7±1.81</td>
<td>26.3±4.59</td>
<td>54±5.89</td>
<td>316±15.98</td>
</tr>
<tr>
<td>3</td>
<td>Zinger powder</td>
<td>Zingiber officinale</td>
<td>8±0.92</td>
<td>5.7±0.77</td>
<td>9±2.09</td>
<td>13±2.99</td>
<td>64.3±7.71</td>
<td>345±17.78</td>
</tr>
<tr>
<td>4</td>
<td>Garlic powder</td>
<td>Allium longicuspis</td>
<td>5±0.54</td>
<td>8±1.09</td>
<td>16.5±2.34</td>
<td>9.9±3.47</td>
<td>60.6±8.37</td>
<td>456±19.39</td>
</tr>
<tr>
<td>5</td>
<td>Flattened rice Snacks</td>
<td>-</td>
<td>8±0.74</td>
<td>2±0.55</td>
<td>9±1.91</td>
<td>3±0.89</td>
<td>81±10.50</td>
<td>342±12.31</td>
</tr>
</tbody>
</table>
The maximum energy content was 342 Kcal/100g in treatment S₄ (developed). S₄ contained highest amount of protein (16.5%) and fiber (9.9%) than others. Carbohydrate content of treatment S₁ (control) (76 g/100 g) was maximum and minimum for treatment S₄ (81 g). S₀ (control) had low fiber content whereas it was increased due to incorporation of dehydrated spices as a result, the developed flattened rice could be recommended to persons requiring high fiber diets. The selected spices mixed flattened rice can therefore be recommended for peoples as ready to eat snacks as well as among others for improving nutritional status of the population due to fiber content. The standard flattened rice available in the market has low nutritional value in comparison to the developed flattened rice incorporated with dehydrated spices.

**Table 3: Physical characteristics of Prepared Flattened Rice Snacks**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Shelf period 0 Month</th>
<th>Shelf period 06 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water Activity (aᵦₚ)</td>
<td>Texture (N)</td>
</tr>
<tr>
<td>S₀</td>
<td>0.298</td>
<td>4.196</td>
</tr>
<tr>
<td>S₁</td>
<td>0.232</td>
<td>2.851</td>
</tr>
<tr>
<td>S₂</td>
<td>0.245</td>
<td>4.100</td>
</tr>
<tr>
<td>S₃</td>
<td>0.258</td>
<td>3.582</td>
</tr>
<tr>
<td>S₄</td>
<td>0.201</td>
<td>5.342</td>
</tr>
</tbody>
</table>

Values are mean; Values are mean of triplicate analysis for water activity (n=50), texture (n=50) and density (n=20)

Water activity (aᵦₚ) of selected spices mixed flattened rice snacks (S₄) was significantly higher than that for different treatments in the Table 3. Data suggest that S₄ snacks would have higher shelf period. Water activity (aᵦₚ) of the S₄ tested varied from 0.201 to 0.223. These aᵦₚ values are typical of very crispy snacks. Previously aᵦₚ of 0.298 for control sample have been reported with undesired microbiological stability in Table 3.

Texture of different treatments (S₀, S₁, S₂, & S₃) was significantly higher than S₄ snacks (Table 3). Data suggest that S₄ was crispier than other treatments as less force (N) was required to break other treatments.

True density (Pᵦ) of control flattened rice snacks was significantly higher than that for selected spices mixed flattened rice snacks (Table 3). However, the bulk density difference between control and developed snacks S₄ was very small (1.385 to 1.375).

![Figure 1: Microbiological count of different samples](image)
Microbiological load of different flattened rice are shown in figure 1. The microbiological load of Sample S_0 is 40-42 cfu/g whereas other treatments are 40-80 cfu/g. It indicates the selected spices mixed flattened rice snacks are comparatively safe for health.

Table 4: Data of sensory scores of different parameters in control and treated flattened rice sample using Hedonic rating Scale

<table>
<thead>
<tr>
<th>Sensory Score</th>
<th>Appearance</th>
<th>Odor</th>
<th>Flavor</th>
<th>Mouth feel</th>
<th>Acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_0</td>
<td>3.21±0.12</td>
<td>3.53±0.09</td>
<td>3.48±0.12</td>
<td>3.90±0.10</td>
<td>1.35±0.14</td>
</tr>
<tr>
<td>S_1</td>
<td>4.21±0.10</td>
<td>3.31±0.29</td>
<td>3.45±0.24</td>
<td>3.87±0.27</td>
<td>1.74±0.26</td>
</tr>
<tr>
<td>S_2</td>
<td>3.86±0.14</td>
<td>3.31±0.19</td>
<td>3.44±0.35</td>
<td>3.89±0.60</td>
<td>1.66±0.06</td>
</tr>
<tr>
<td>S_3</td>
<td>3.90±0.12</td>
<td>3.92±0.39</td>
<td>3.47±0.31</td>
<td>3.82±0.45</td>
<td>1.63±0.06</td>
</tr>
<tr>
<td>S_4</td>
<td>5.12±0.11</td>
<td>4.10±0.26</td>
<td>3.95±0.12</td>
<td>5.34±0.41</td>
<td>1.85±0.05</td>
</tr>
</tbody>
</table>

Values are mean±SEM; n = 30. Appearance, Odor, Flavor and Mouth feel were on a scale of 1-5 (Like very much = 5, like slightly = 4, neither like nor dislike = 3, dislike slightly = 2 and dislike very much = 1); Acceptance was on scale of 1-2 (Acceptable = 1).

In a house trained panelist for sensory evaluation (N=30) judged natural spices mixed flattened rice snacks (S_4) was significantly (P < 0.01) superior for appearance, flavor, taste and overall acceptability than other treatments (Table 4).

Appearance of the Sample S_0 was significantly higher to that of other treatments i.e. 5.12±0.11 for S_4, 4.21±0.10 for S_1, 3.86±0.14 for S_2, 3.90±0.12 for S_3. Odor of sample S_3 was judged to be significantly preferred to that of other four snacks tested. The scores are 4.10±0.26 for S_0, 3.31±0.29 for S_1, 3.31±0.19 for S_2, 3.92±0.39 for S_3, and 3.53±0.09 for S_4 respectively. Flavor was judged to be similar for all the four kinds of snacks tested accept sample S_1 (3.95±0.12). Mouth feel of four flattened rice samples were almost similar to each one and significantly higher score of S_4 is 5.34±0.41. Panelist acceptance % of ready to eat flattened rice snacks is shown in Table 4 and Figure 2.

![Acceptability of Flattened Rice Sample](image)

**Figure 2: Acceptability rating score of flattened rice snacks**

Acceptance of sample S_0 was significantly higher than other samples. Acceptance of four samples (4) was similar to each other in test. Acceptance score for various sample tested was s_0 1.85, s_1 1.74, S_2
1.66, S3 1.70, and S0 1.35, respectively. Data suggest that 1.85 score of S4 would be considered encouraging. However, no sensory evaluation data was shown to have valid comparison with liking snacks reported herein.

The results of statistical analysis of sensory evaluation of developed flattened rice snacks using different ratio of selected spices mix and stored for 6 months are presented in Table 5. Scores of flavor, taste, texture, and overall acceptability of control and other treatments were not significantly (P > 0.05) affected by spices mix added at zero time. Taste, flavor, mouth feel, and overall acceptability score values showed a preference of panelists to samples prepared with 1% of bay leaves powder, 1.0% of ginger powder, 1% garlic powder and 1% of selected spices powder mix compared to the control sample with significant differences (P < 0.01). Storing the developed samples for 6 months not significantly (P < 0.01) affected the appearance or color of all studied samples.

At the same time, no significant differences in taste, flavor, mouth feel, and overall acceptability were observed between the samples prepared using 1.0% selected spices mix powder after storage period samples at zero time, while samples prepared with spices ratios about 1.0% and stored for 6 months showed a significant differences (P < 0.01) in the aforementioned quality attributes compared to those at zero time. Generally, flattened rice snake sample prepared using 1.0% selected spices powder gave significantly (P < 0.01) the highest overall acceptability scores at zero time and after 6 months compared to those of the control and treatment S4.

Table 5: Summary of ANOVA on Data for Sensory evaluation

<table>
<thead>
<tr>
<th>Sources</th>
<th>SS</th>
<th>Df</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment between group</td>
<td>20.8738</td>
<td>4</td>
<td>5.2185</td>
<td>23.1</td>
<td>0.01</td>
</tr>
<tr>
<td>Error</td>
<td>4.518</td>
<td>20</td>
<td>0.2259</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25.3919</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis of variance (ANOVA) reveals that the calculated value of F (23.1) is greater than table value (3.84) on 4, 20 (d. f.) at 1% probability level. Therefore, it can be concluded that there was a significant difference (p < 0.01) between treatments regarding the overall acceptability of the product. Spices have antimicrobial property and it act as traditional food preservative, which increases the shelf life of the product (Table 5).

Conclusion

At present, most of the flattened rice snacks are used as ready to eat forms in different delicious condiments and spices.

Due to moisture activity, the samples show less crispiness and a little bit bitter taste. So, natural spice powder preservative will create new taste and increase shelf life.

References


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- Use footnotes sparingly (or not at all) and place them at the bottom of the column on the page on which they are referenced. Use Times 8-point type, single-spaced.
- British/Canadian spelling should be adopted. Acronyms should be spelled out at first mention, but not thereafter unless there will be any good reason to do so.
- List and number all references in 9 point Times New Roman, Italic, single-spaced, at the end of your paper. When referenced in the text, enclose the citation number(s) in superscript, for example 1,5. Only those references actually cited in the paper should be listed. References should be numbered according to when they are first mentioned in the paper. All authors of a paper must be listed in the references. We do not support the use of et al. in the reference list.
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Provide full citations in your Reference List, included starting as a new page at the end of your document. Follow the Vancouver reference style as stated following examples for different types of resources:

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- Articles in Journals
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More than Six Authors/Editors

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E-book

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Cite authors in the same way for all types of resources: articles, websites, videos, etc. List up to the first 6 authors/editors, and use “et al.” for any additional authors.
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Volume Number(Issue Number): Page Numbers.

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