

DEVELOPMENT AND QUALITY CHARACTERISTICS OF COOKIES INCORPORATED WITH RED RICE (*ORYZA SATIVA*) OF ARUNACHAL PRADESH

¹Gebi Karbak and ²Birinchi Bora

¹M.sc Food, Nutrition and Dietetics

²Assistant Professor, Department of Food, Nutrition and Dietetics

Department of Food, Nutrition and Dietetics, Assam down town University, Guwahati, Assam, India.

ABSTRACT: Rice (*Oryza sativa*) is a cereal accepted worldwide. About 60% of total calories taken by the population come from cereal. Rice is nutritious as it contains protein, carbohydrates, crude fibre, fats, ash mineral viz Ca, P, Fe, Na, K and vitamin such as thiamine, riboflavin, niacin, tocopherols. Red rice is those which has red layer on the bran. The color red is due to the deposition of anthocyanin in different layers of seed coat, pericarp and aleurone. Cookies are popular amongst all the age group of people because of its affordable price, shelf stable, convenience and nutritive value. Red rice can improve the nutritional value of cookies. It has certain health benefits such as healing anemia, stimulation of blood circulation, treating diabetes, helps in boosting kidney function and prevents diseases such as Alzheimer's disease and cancer. Sensory score of cookies increased significantly with increase in level of rice flour. Out of 10 formulations, mean color score was highest in Sample 10 i.e. 8.03. In case of appearance Sample 10 got the highest score i.e. 8.33 whereas Sample 7 had lowest score 6.7. The score of taste was high in Sample 10 i.e. 8.06 and lowest in Sample 7 with the score 6.96. Sample 9 had the highest score for the texture with the maximum score of 7.83 and lowest in Sample 1 with 6.93. In case of flavor, Sample 8 got the highest score i.e. 8.33 whereas Sample 5 got the lowest i.e. 6.8 and Sample 10 got the highest overall acceptability and Sample 9 got the lowest score i.e. 6.8. Sensory score of cookies increased significantly with increased with increase in level of rice flour. There was slight variation observed among the scores during the storage period up to 15 days in terms of color, appearance, taste, texture and flavor. Except for the texture, other attributes remained same from the time of baking.

KeyWords: Cookies, Health Benefits, Nutrients, Red rice, Sensory Attributes, Sensory Evaluation.

1. INTRODUCTION

Rice (*Oryza sativa*) is a cereal accepted worldwide and it is considered as staple food in developing nations. Asia produces 91% of rice in the world. About 705 varieties of rice are found in India (Thongbam P.D *et al.*, 2011). India is the second largest country in the production of rice after China (Rathna P *et al.*, 2019).

About 60% of total calories taken by the population come from cereal (Itagi and Singh, 2015). Generally, rice is consumed as the white rice with removal of husk, bran and germ (Mudoj and Das, 2019). Rice is rich in nutrients. It includes protein, carbohydrates, crude fibre, fats, ash mineral viz Ca, P, Fe, Na, K and vitamin such as thiamine, riboflavin, niacin, tocopherols (Verma D.K *et al.*, 2011). It has good digestibility, biological value and good quality protein because of the presence of higher amount of lysine. Nutrient content is higher in unmilled rice (coloured rice) than in milled or polished rice. There is 7g/100g protein, 5.5g/100g iron, 3.3g/100g zinc and 2g/100g fibre in red rice (Raghuvanshi R.S *et al.*, 2017).

Red rice has red layer on the bran (Ahuja U *et al.*, 2007). The color red is due to the deposition of anthocyanin in different layers of seed coat, pericarp and aleurone (Raghuvanshi R.S *et al.*, 2017). In Asia, rice has been known and grown as various different colors such as red, purple, black, brown, yellow and green. The colored rice is as old as rice itself. Red rice is preferred by people in many parts of India, Bhutan and Sri Lanka while the royals of China prefer black flavored rice. It has occupied a special position in India (Ahuja U *et al.* 2007). The red rice is superior to white rice. Iron, magnesium, calcium and zinc are higher in red rice as compare to white rice. Also has higher concentration of crude protein and crude fiber content. It has excellent antioxidant properties such as total phenolic content and total flavonoid content. (Raghuvanshi R S *et al.*, 2017).

There are certain health benefits of colored rice such as healing anemia, stimulation of blood circulation, treating diabetes, helps in boosting kidney function and prevent diseases such as Alzheimer's disease and cancer. Other benefits like presence of anti-inflammatory functions, allergy prevention and also helps in cutting down the weight. Presence of magnesium helps in reducing migraine and blood pressure. Calcium keeps bone and teeth strong along w with prevention of arthritis and osteoporosis. Increase in the immunity due to the presence of selenium. Vitamin E prevents skin cancer, prevents sunburn and improves nail. Vitamin B reduces the level of stress, anxiety and depression symptoms and also enhances neurological function (Sati and Singh, 2019).

Red rice is said to be good for diabetes as it has lower glycemic index (Raghuvanshi R.S *et al.* 2017). In most part of the world cookies are the largest category of snack. It is a form of confectionery product with low moisture content (Gernah S *et al.*, 2015). Cookies are popular amongst all the age group of people because of its affordable price, shelf stable, convenience and nutritive value. The main ingredients used in baking cookies are refined flour, sugar, hydrogenated fats and other ingredients such as additives and emulsifiers (Ho and Latif, 2018). It is flat, hard, crunchy and ready to eat. According to the method of preparation, cookies are classified drop, refrigerated, moulded, presses, and bar or rolled (Norhidayah M. *et al* 2014). It is ready to eat, readily digestible, appetizing products made from unpalatable dough. They are rich source of fats, proteins and carbohydrate thus provides energy. It also provides minerals as well (Adekunle and Mary, 2014). They can be developed with an adequate substitute of wheat. However, the substitution of wheat must be readily available, cheap and should have some functional properties (Gernah S *et al.*, 2015).

2. MATERIALS AND METHODS

The experimental procedures followed to pursue the research pertaining to this present study “**Development and quality characteristics of cookies incorporated with red rice (*Oryza sativa*) of Arunachal Pradesh**” are detailed in this chapter under the following headings:

SAMPLE COLLECTION

Collection of raw material

For carrying out the current study required sample of red rice was collected from the local areas of Naharlagun, Arunachal Pradesh. Other basic ingredients required for cookies were collected from local market of Guwahati, Assam.

Processing of raw materials

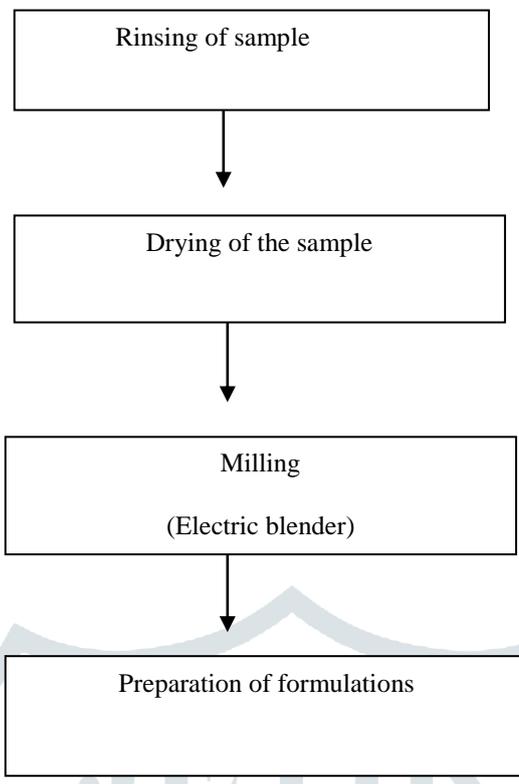


Fig 1:-Flow diagram of sample preparation and processing

FORMULATION OF DEVELOPED COOKIES

There will be 10 different formulations of cookies and they are given below;

Table 1: Formulation of developed cookies

Formulations	Ingredients	
	Refined flour	Red rice flour
Sample 1	90	10
Sample 2	80	20
Sample 3	70	30
Sample 4	60	40
Sample 5	50	50

Sample 6	40	60
Sample 7	30	70
Sample 8	20	80
Sample 9	10	90
Sample 10	-	100

FLOW CHART OF PRODUCT DEVELOPMENT:

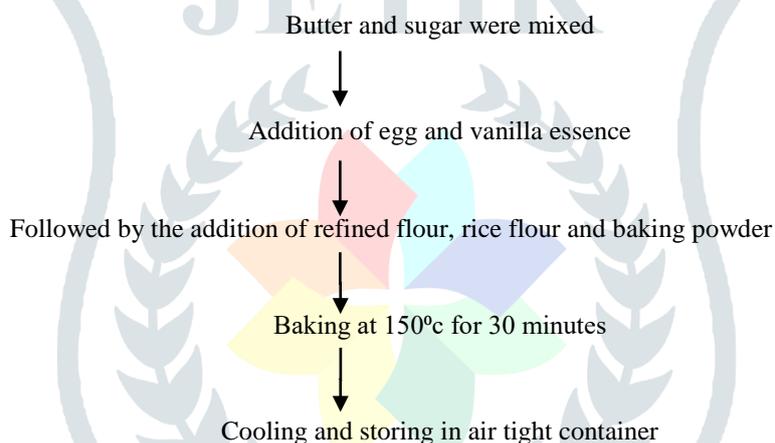


Fig 2: Method for preparation of cookies

SENSORY EVALUATION OF DEVELOPED COOKIES

Sensory evaluation is done to check the overall acceptability of the cookies that comprises of color, appearance, taste, texture and flavor. It was evaluated by 30 panelists using nine point hedonic scale. The further research was conducted on the cookies which was most appreciable.

The acceptability trial was in the laboratory of Department of Food, Nutrition and Dietetics under the following manner:

Formulation of score card

Selection of panel

Conduction of acceptability treats

FORMULATION OF SCORE CARD

The most widely used scale for measuring food is the 9-point hedonic scale. The sensory evaluation of the developed product was done using the same measuring scale.

Table 2: 9-Point hedonic scale

9	Like extremely
8	Like very much
7	Like moderately
6	Like slightly
5	Neither like nor dislike
4	Dislike slightly
3	Dislike moderately
2	Dislike very much
1	Dislike extremely

SELECTION OF PANEL

Sensory evaluation was done by a semi trained panel consisting of 30 members from Department of Food, Nutrition and Dietetics. Panelists were selected on their willingness to take part in sensory evaluation.

CONDUCT OF ACCEPTABILITY TRIAL

The acceptability trials were done by 30 panelists from the Department of Food, Nutrition and Dietetics using the 9-point hedonic scale. This was conducted inside the laboratory of Department of Food, Nutrition and Dietetics. There were 10 developed cookies made for sensory evaluation. The cookies were served on a plate and kept on table for the evaluation. The panelist had to taste and give a remark. Panelists were asked to rinse their mouth after each eating in order to appreciate full sensory character of each cookie. They have to evaluate the samples on the basis of color, appearance, taste, texture, flavor and overall acceptability.

MOISTURE CONTENT ANALYSIS

The moisture content was determined by oven drying method using standard AOAC (1975) procedure. Five grams of sample was weight into a previously weight moisture cup and dried in an oven at 60°C till a constant weight was attained.

$$\text{Moisture (\%)} = \frac{\text{Initial weight (g)} - \text{final weight (g)}}{\text{sample weight (g)}}$$

SHELF LIFE OF DEVELOPED PRODUCT

Shelf life or storage study was done to assess the overall hygiene maintained during the process of preparation of cookies. For that sensory evaluation and microbial study were done which are discussed in detail in below.

SENSORY EVALUATION OVER STORAGE

The shelf life of cookies is very important. The developed cookies were stored in plastic containers for 15 days and its quality parameters i.e. color, appearance, etc. were studied. Cookies were stored at room temperature (26°C).

DETERMINATION OF COLONY PRESENT IN DEVELOPED COOKIES

This method for estimating microorganism was modified by Tate (1995), though various methods were available to isolate and enumerate microorganisms (bacteria, fungi, actinomycetes, protozoa, algae, virus and mycoplasma) from soil, food stuffs, milk and water. The most commonly used procedures for the isolation and enumeration of fungi, bacteria and actinomycetes which are most prevalent microorganisms are the serial dilution agar plating method or viable count method. This method is based upon the principle that material containing microorganisms appearing on the plates represents the number of living organisms present in the sample.

The number of colonies appearing on dilution plates are counted, averaged and multiplied by the dilution factor to find the number of cells/pores per gram (or milligram) of sample:

$$\text{No. of cells/ml or g} = \frac{\text{No. of colonies} \times \text{Dilution factor}}{\text{Dry weight of cookies sample}}$$

3. RESULTS AND DISCUSSION

COLLECTION OF SAMPLE

A preliminary market survey was carried out in markets of Naharlagun, Papum Pare district, Arunachal Pradesh. Information and other data were collected by interviewing with the sellers. Red rice was selected because there was no any product developed with red rice. Red rice was collected from daily market in Naharlagun, Arunachal Pradesh.

FORMULATIONS AND STANDARDIZATION OF COOKIES

Red rice was used to develop cookies following various methods of formulations to enhance the quality, taste, texture and flavor. There are 10 different formulations of cookies and done in the laboratory of Department of Food, Nutrition and Dietetics.

ACCEPTABILITY TRIALS OF FORMULATED COOKIES

Acceptability of a product is determined by sensory evaluation. The pleasure of product is closely related to the senses and in case of food it is mainly aroma, taste and texture. Sensory evaluation is an active field concentrating on the utilization of human for the measurement of sensory perception and/or their effects on food and taste acceptance. Acceptability trials were conducted by a panel of semi trained judges consisting of 30 numbers of students from Department of Food, Nutrition and Dietetics. Scoring was done using 9-hedonic scale. The entire panelist was not in a habit of chewing tobacco, smoking etc.

Table no. 3: Mean acceptability scores of formulated cookies

Product	Formulation	Quality Attributions					
		Color	Appearance	Taste	Texture	Flavor	Overall Acceptability
Red Rice Cookies	Sample1	6.76±1.11	7.63±1.11	7.2±1.32	6.93±0.96	7.3±1.03	6.93±1.36
	Sample2	7.1±1.27	7.1±1.27	7.86±1.20	7.13±1.35	7.1±1.19	7.5±1.05
	Sample3	7.17±1.08	7.3±0.86	7.2±1.04	6.96±1.07	7.26±0.81	7.2±1.04
	Sample4	7.17±1.08	7.33±1.01	7.43±0.9	7.26±0.96	6.93±1.36	7.33±1.19
	Sample5	7.3±0.86	7.43±1.05	7.16±1.09	7.1±61.1	6.8±1.07	7.1±1.13
	Sample6	6.93±1.28	7.16±1.06	7.33±1.16	7±0.96	7.46±1.25	7.46±1.25
	Sample7	7.06±1.22	6.7±1.29	6.96±1.25	7.4±1.22	7.13±0.88	7.33±0.82
	Sample8	6.96±0.98	7.10±1.02	7.13±1.17	7.13±0.93	8.33±0.96	7.13±1.17
	Sample9	7.4±0.98	7.06±1.03	7.26±0.89	7.83±0.77	7.33±1.22	6.8±1.07
	Sample10	8.03±1.07	8.33±0.90	8.06±1.06	7.26±0.99	8.16±1.00	8.36±0.91

From Table 3 it can be observed that while considering the mean color score of the 10 formulations, Sample 10 got the highest score i.e. 8.03 and Sample 1 got the lowest score i.e. 6.76. In case of appearance Sample 10 got the highest score i.e. 8.33 whereas Sample 7 had lowest score 6.7. The score of taste was high in Sample 10 i.e. 8.06 and lowest in Sample 7 with the score 6.96. Sample 9 had the highest score for the texture with the maximum score of 7.83 and lowest in Sample 1 with 6.93. In case of flavor, Sample 8 got the highest score i.e. 8.33 whereas Sample 5 got the lowest i.e. 6.8 and Sample 10 got the highest overall acceptability and Sample 9 got the lowest score i.e. 6.8. During the acceptability trials it was found that among the 10 samples, only one sample was selected which got the highest score. Therefore based on the acceptability of sensory attributes Sample 10 was selected for carrying out further analysis.

SENSORY EVALUATION OF THE DEVELOPED COOKIES

The procedure to measure product differences, perceived characteristics, quality and acceptability is known as sensory evaluation. It is also defined as sensory attributes of color, aroma, flavour, taste and overall acceptability by using the 9 point hedonic scale.

Color

Color evokes taste buds and stimulates the appetite. Sample 10 showed the most preferred color with score (8.03) and least preferred was in Sample 1 (6.76).

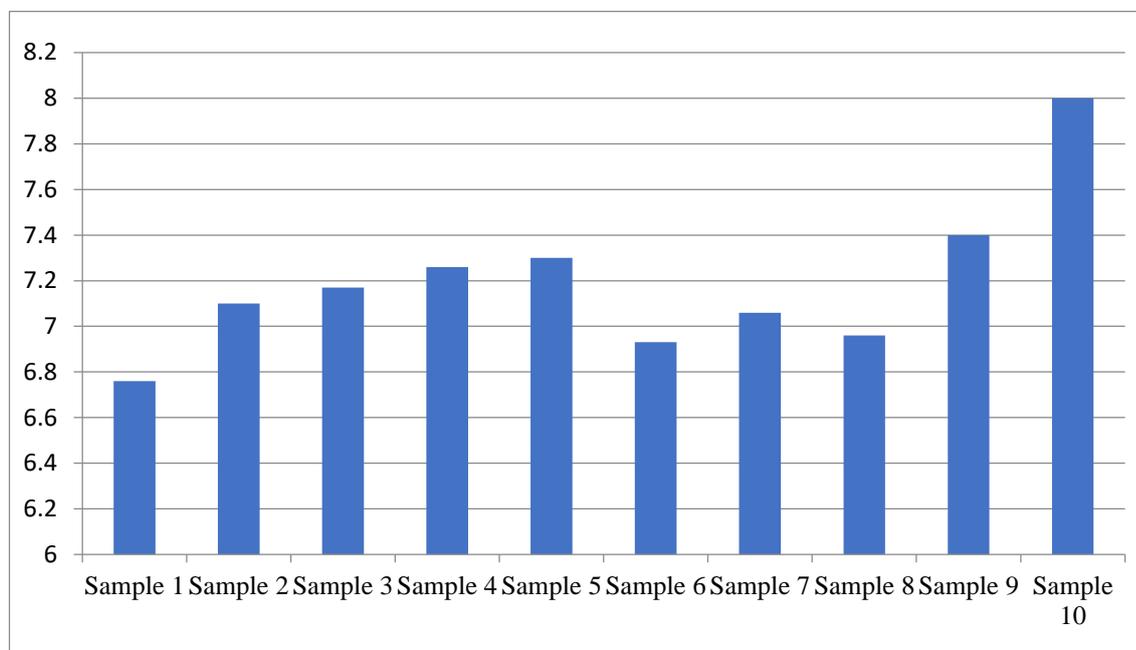


Figure 3: Panellist scores of acceptance test for colour (Hedonic scale of 1-9, where 9 represents 'like very much' and 1 represents 'dislike very much')

Appearance

Generally the first feature that can be perceived by the senses is by the appearance of the product. The appearance factor includes shape, surface condition, transparency or visible texture properties.

Sample 10 was most preferred in terms of appearance from all other samples with the highest score (8.33).

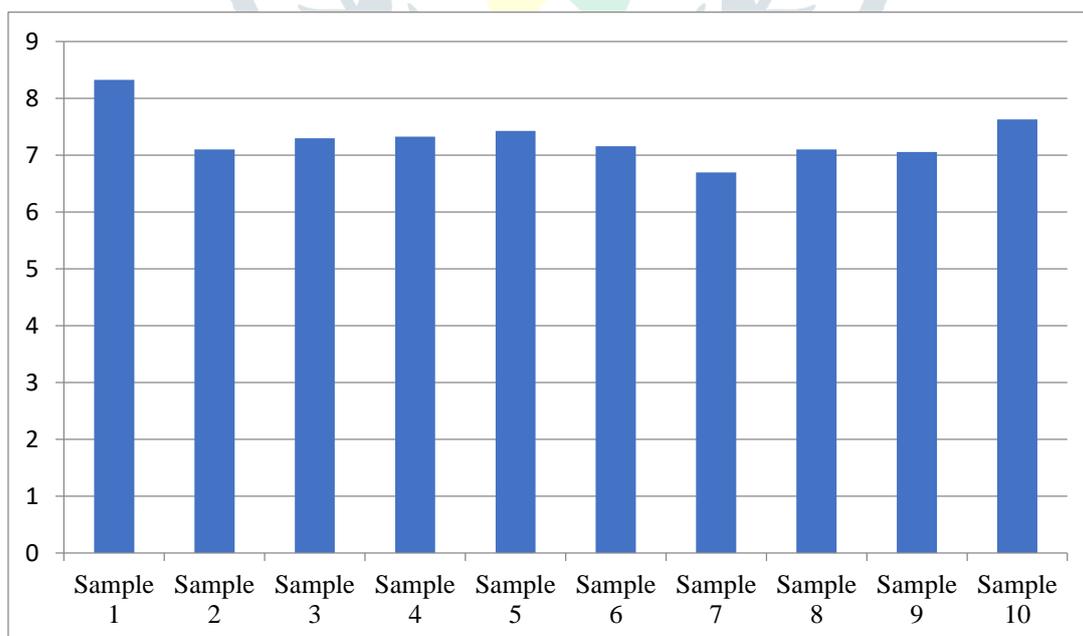


Fig 4: Panellist scores of acceptance test for appearance (Hedonic scale of 1-9, where 9 represents 'like very much' and 1 represents 'dislike very much').

Taste

The sensory depends on our taste buds. Taste bud which is located on small bumps on the tongue is known as fungiform papillae.

Amongst the entire product, Sample 10 (8.06) was most preferred by the panelist and least preferred was Sample 7 with the score (6.96).

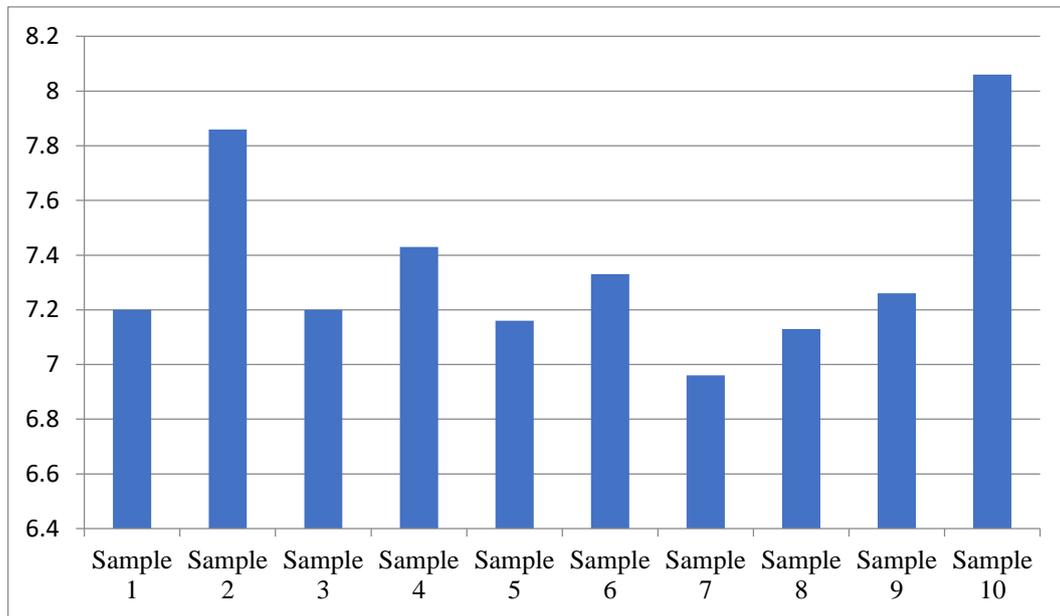


Fig 5: Panellist scores of acceptance test for taste (Hedonic scale of 1-9, where 9 represents 'like very much' and 1 represents 'dislike very much').

Texture

The most preferred product for texture was Sample 9 with the score (7.83) and least preferred was in Sample 1 (6.93).

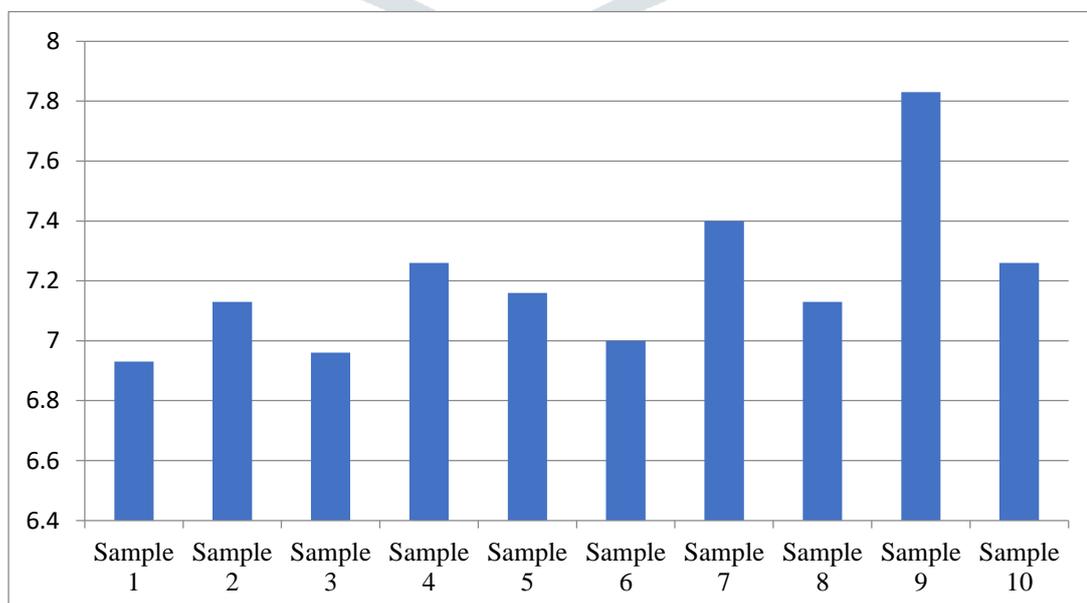


Fig 6: Panellist scores of acceptance test for taste (Hedonic scale of 1-9, where 9 represents 'like very much' and 1 represents 'dislike very much').

Flavor

Flavor is the combined senses of taste, aroma and mouth feel. Mouth feel encompasses textural and chemical sensations. Sample 8 (8.33) was mostly preferred by all panelist and least preferred was in Sample 5 (6.8).

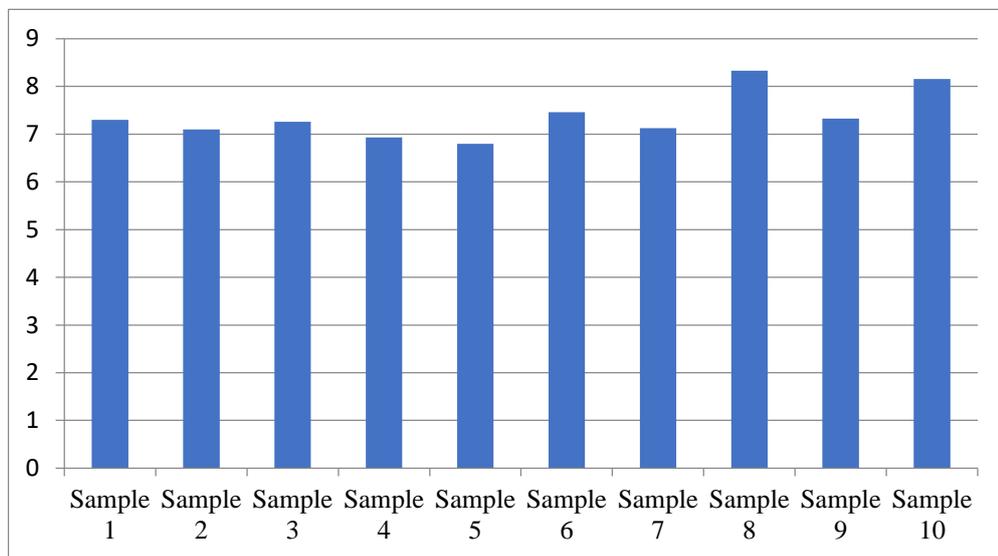


Fig 7: Panellist scores of acceptance test for flavour (Hedonic scale of 1-9, where 9 represents 'like very much' and 1 represents 'dislike very much').

Overall acceptability

Sample 10 was the most accepted product with the score (8.36), followed by Sample 2 (7.5) and least preferred was Sample 9 with the score (6.8).

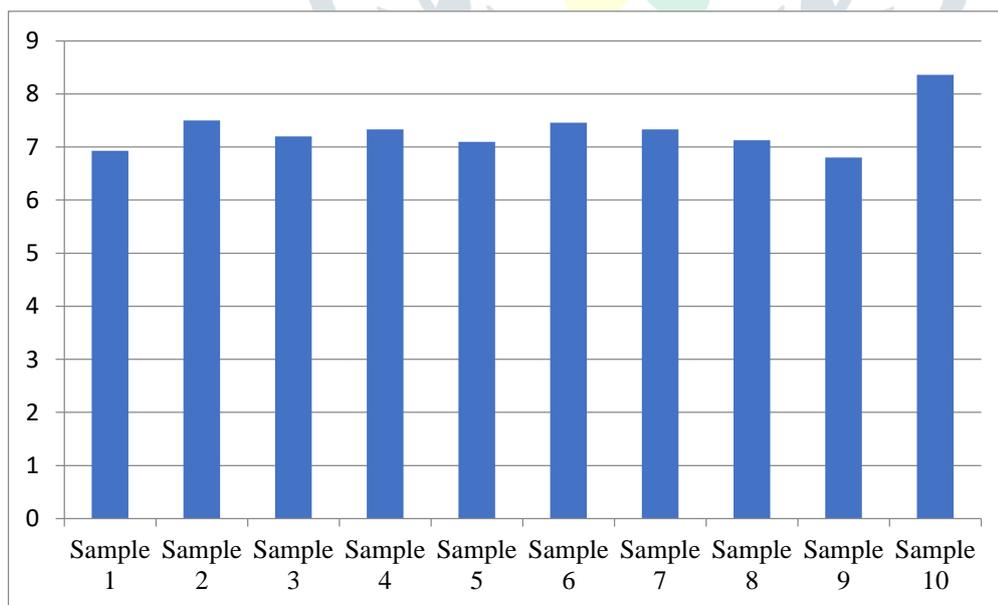


Fig 8: Panellist scores of acceptance test for overall acceptability (Hedonic scale of 1-9, where 9 represents 'like very much' and 1 represents 'dislike very much').

MOISTURE CONTENT ANALYSIS OF FORMULATED COOKIES

Cookies are baked to lower moisture content. When the moisture content of cookies is below 5 percent after baking, it results in crisp texture and good storage stability. The important factor of bakery product is its moisture content as it has a direct impact on the texture and attributes and a strong correlation has been found between moisture content and firmness

The present study determined the moisture content of developed cookies. It was observed that moisture content of cookies was 4.6%.

Table 4: Moisture content of cookies

Moisture content (%)	Developed Cookies
	4.6%

SHELF LIFE STORAGE AND MICROBIAL COUNT STUDIES OF THE FORMULATED COOKIES

The shelf life of cookies relies on a variety of agents, such as the sell by date, the preparation method and how the cookies were stored. Due to its relatively low cost and high calorie density, cookies are a popular and very portable dessert.

Cookies were prepared under good hygienic condition and packaging material used were not compromised. Total viable count results showed on Sample 10 after 15 days of storage. There were 5 number of colonies found in the cookies. It took 24 hours for the microbial colonies to form. Organisms tend to grow faster in a culture that has high nutrient content. Fungal growth on foods could lead to deposit of mycotoxin on foods which are a public health concern (Yusufa P A *et al.*, 2016). This study has showed that the cookies developed from red rice flour were microbiologically safe during 15 days of storage.

Table 5: Microbiological quality (c.f.u/gm) of the food sample

Product code	Total viable count
	15 days
Sample10	5

SENSORY EVALUATION OVER STORAGE

The formulated cookies which were widely accepted by the panelists were kept in a container for further studies.

The shelf life of formulated product was studied by storing the product in plastic air tight container for a period of 15 days. The evaluation was done after 15 days from the time of storing.

Table 6: Sensory evaluation over storage of cookies

Product	Formulation	Quality Attributions					
		Color	Appearance	Taste	Texture	Flavor	Overall Acceptability
Red Rice Cookies	Sample 10	8.03±1.07	8.33±0.90	8.06±1.06	7±0.96	8.16±1.00	8.36±0.91

Table no. 6 depicted the sensory scores by using 9 point hedonic scale after storage for 15 days of the selected product. There was slight variation observed among the scores during the storage period up to 15 days in terms of color, appearance, taste, texture and flavor. Except for the texture, other attributes remained same from the time of baking.

NUTRITIVE VALUE OF RAW INGREDIENTS USED IN COOKIES

Table 7: Nutritive value of raw ingredients per 100g

Name	Amount (g)	Energy (kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Fibre (g)
Red rice flour	100	341	70.19	10.49	1.81	2.71
Sugar	50	193.5	50	-	-	-
Butter	50	364.5			40.5	-
Egg	25	43.25	-	3.325	3.325	-
Baking powder	1.25	1.53	0.375	0.0015	-	-
Total		943.78	120.566	13.8165	45.635	2.71

Nutritive value of the selected formulation of cookies which is Sample 10 was calculated. The nutritive value of red rice flour is same as that of white rice but its glycemic index is low. The developed cookies were found to have energy (943.78), carbohydrates (120.566), protein (13.8165), fats (45.635) and fibre (2.71).

4. SUMMARY AND CONCLUSION

FORMULATION OF THE MUFFINS INCORPORATED WITH RED RICE

The raw materials used for development of cookies were red rice flour (*Oryza sativa*). These raw materials were mixed in different proportions to form a formulation. Ten formulations were formed with varying amounts of red rice flour (*Oryza sativa*) while keeping the amount of basic ingredients constant.

SENSORY EVALUATION OF THE DEVELOPED COOKIES

An acceptability trial was conducted by a panel of 30 semi trained panelists from the Department of Food, Nutrition and Dietetics. Sensory evaluation was carried out using the affective testing method where the degree of like and dislike is ranked according to the 9 point hedonic scale.

Developed product was coded as Sample 1, Sample 2, Sample 3, Sample 4, Sample 5, Sample 6, Sample 7, Sample 8, Sample 9 and Sample 10. The panelists were required to rinse their mouth after each tasting in order to appreciate the full sensory character of each individual product.

Out of the ten cookies formulations Sample 10 exhibited the highest score for all the sensory attributes in terms of color (8.03), appearance (8.33), taste (8.06), texture (7), flavor (8.16) and overall acceptability (8.36). Therefore based on acceptability trials among Sample 1, Sample 2, Sample 3, Sample 4, Sample 5, Sample 6, Sample 7, Sample 8, Sample 9 and Sample 10, Sample 10 was selected for carrying further test for its moisture content and microbial count after storage for 15 days.

Sensory evaluation was carried out at the Department of Food, Nutrition and Dietetics, Assam down town University, Guwahati, Assam.

SHELF LIFE STUDY OF THE DEVELOPED MUFFINS

The shelf life of the red rice flour (*Oryza sativa*) incorporated cookies were studied by storing for 15 days in high density polyethylene (HDPE) containers at room temperature. There were no changes seen in the developed cookies in 15 days of storage.

CONCLUSION

In conclusion, it can be summarized that the cookies developed from red rice have a great acceptability score and it has certain health benefits such as healing anemia, stimulation of blood circulation, treating diabetes, helps in boosting kidney function and prevent diseases such as Alzheimer's disease and cancer.

Out of 10 formulations, mean color score was highest in Sample 10 i.e. 8.03. In case of appearance Sample 10 got the highest score i.e. 8.33 whereas Sample 7 had lowest score 6.7. The score of taste was high in Sample 10 i.e. 8.06 and lowest in Sample 7 with the score 6.96. Sample 9 had the highest score for the texture with the maximum score of 7.83 and lowest in Sample 1 with 6.93. In case of flavor, Sample 8 got the highest score i.e. 8.33 whereas Sample 5 got the lowest i.e. 6.8 and Sample 10 got the highest overall acceptability and Sample 9 got the lowest score i.e. 6.8. Sensory score of cookies increased significantly with increased significantly with increase in level of rice flour. There was slight variation observed among the scores during the storage period up to 15 days in terms of color, appearance, taste, texture and flavor. Except for the texture, other attributes remained same from the time of baking. A formulated cookie with 100g of red rice was preferably accepted widely amongst the panelists. The cookies kept in airtight container were fresh and edible even after 15 days as its moisture content is low. Cookies retained its quality attributes i.e. color, appearance, flavor and taste, and no signs of spoilage were visible till 15 days.

REFERENCES

1. Ahuja, U., Ahuja, S. C., Chaudhary, N., & Thakrar, R. (2007). Red rices—past, present and future. *Asian Agri-History*, 11(4), 291-304.
2. Das, A., Kesari, V., & Rangan, L. (2010). Aromatic joha rice of Assam-A review. *Agricultural Reviews*, 31(1), 1-10.
3. Ho, L. H., & Abdul Latif, N. W. B. (2016). Nutritional composition, physical properties, and sensory evaluation of cookies prepared from wheat flour and pitaya (*Hylocereus undatus*) peel flour blends. *Cogent Food & Agriculture*, 2(1), 1136369.
4. tIagi, H. N., & Singh, V. (2015). Status in physical properties of coloured rice varieties before and after inducing retro-gradation. *Journal of food science and technology*, 52(12), 7747-7758.
5. Mudoj, T., & Das, P. (2019). A Study on Phytochemicals and Mineral Content of Indigenous Red Rice of Assam, India. *Int. J. Curr. Microbiol. App. Sci*, 8(4), 1-12.
6. Norhidayah, M., Noorlaila, A., & Nur Fatin Izzati, A. (2014). Textural and sensorial properties of cookies prepared by partial substitution of wheat flour with unripe banana (*Musa x paradisiaca* var. Tanduk and *Musa acuminata* var. Emas) flour. *International Food Research Journal*, 21(6).
7. Olapade, A. A., & Adeyemo, M. A. (2014). Evaluation of cookies produced from blends of wheat, cassava and cowpea flours. *International Journal of food studies*, 3(2).
8. Priya, T. R., Nelson, A. R. L. E., Ravichandran, K., & Antony, U. (2019). Nutritional and functional properties of coloured rice varieties of South India: a review. *Journal of Ethnic Foods*, 6(1), 11.
9. Raghuvanshi, R. S., Dutta, A., Tewari, G., & Suri, S. (2017). Qualitative characteristics of red rice and white rice procured from local market of Uttarakhand: a comparative study. *J rice Res*, 10, 49-53.
10. Sati, R., & Singh, S. (2019). Pigmented rice: A potential ingredient for extruded products reviews paper. *Journal of Pharmacognosy and Phytochemistry*, 8(3), 700-702.
11. Sengev, I. A., Gernah, D. I., & Bunde-Tsegba, M. C. (2015). Physical, chemical and sensory properties of cookies produced from sweet potato and mango mesocarp flours. *African Journal of Food, Agriculture, Nutrition and Development*, 15(5), 10428-10442.
12. Thongbam, P. D., Raychaudhury, M., Durai, A., Das, S. P., Ramesh, T., Ramya, K. T., ... & Ngachan, S. V. (2012). Studies on grain and food quality traits of some indigenous rice cultivars of North-eastern Hill Region of India. *Journal of Agricultural Science*, 4(3), 259.
13. Yusufu, P. A., Netala, J., & Opega, J. L. (2016). Chemical, sensory and microbiological properties of cookies produced from maize, african yam bean and plantain composite flour. *Indian Journal of Nutrition*, 3(1), 122.