"Nutritional profiling & Examination of packaging capability of value-added rice candy"

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Abstract

An attempt was made to create a rice-based candy that also contained dry mushroom and walnut! powder in order to create a nutri candy for the teenage population that is unable to obtain the necessary nutrition value from their food on a regular basis. Here analysis of the nutritional value , morphological structure, antimicrobial testing and etc was done The moisture content of mushroom powder, walnut powder and rice powder were found to be 12%, 6% and 10% respectively. Ash content was to found m maximum in rice powder, then in walnut powder and least in the mushroom powder. The FTIR spectra of prepared rice base candy show prominent peak at 3375.2 cm^{-1} and the stretching vibration peak of hydroxyl in the molecule indicating that was successfully embedded in the starch molecule. Vitamins & carbohydrates are observed at 855.7 and 572.3 $cm^{-1.}$, it was observable from the cross-sections of film that the control film surface was smooth, while the candy film was little bit rough. This phenomenon was due to the rising fiber concentration and apparent fibre. The scanning electron microscopy morphology of the surface of the rice base candy at different magnification levels (×200(1), ×1000(2) and ×1,800(3)) . The control film showed a compact, even and relatively smooth structure without porosity. it was observed from the cross-sections of film that the control film surface was smooth, while the candy film was little bit rough. This phenomenon was due to the rising fiber concentration and apparent fibre. CS control film and fibers reinforced blend film were screened for antibacterial activity against Staphylococcus aureus (Gram-positive bacteria) and Escherichia coli (Gram-negative bacteria) by employing the agar disc diffusion technique . The existence of a distinct inhibitory zone around the disc of each film shows activity against E. coli and S. aureus. The interaction of positively charged and negatively charged bacterial cell membranes causes membrane permeability loss and intracellular component leakage, ultimately killing the bacterium. The antibacterial activity of films against Staphylococcus aureus and Escherichia coli bacteria was moderate.

Introduction

Candies are more palatable food item, composed of sweet taste and high calorie**.** Candies are very popular because growth of brain is at most at this age. And for this we have to provide them essential nutrition. The brain needs protein fats, Iron, Zinc, Iodine and vitamin-12 in early growth and for this we have need food which are enriched we these nutrients. Walnut, mushroom and cashew are some products which are highly nutritious and used as a supplement to boost the nutritious level of food. among children, specially the age between 5- 12yrs. The time of this age is very crucial time for children. The walnut is mainly marketed with shell. The demanding consumer searches for large size walnuts, tasteful, well-dried, with 10% of moisture content and healthy. If they are of small size, they are used to decorticate and the kernel is mainly intended for confectionary. According to the color of the seed, somewhat pale, and the taste, we distinguish different varieties although they do not all have the same acceptance. Walnuts without shell are 4% water, 15% protein, 65% fat and 14%carbohydrates, including, 7% dietary fiber (table). In a 100-gram reference serving, walnuts provide 2740 kilojoules(654kcal) and rich content (20% or more of the Daily value or DV) of several dietary minerals, particularly manganese at 163% DV, and B Vitamins. A mushroom or toadstool is the fleshy, spore-bearing fruiting body of a fungus, typically produced above ground, on soil, or on its food source. . "Mushroom" also describes a variety of other gilled fungi, with or without stems, therefore the term is used to describe the fleshy fruiting bodies of some Ascomycota. The gills produce

microscopic spores which help the fungus spread across the ground or its occupant surface. Edible mushrooms include many fungal species that are either harvested wild or cultivated. Edible mushroom species have been found in association with 13,000-year-old archaeological sites in Chile. Ötzi, the mummy of a man who lived between 3400 and 3100 BCE in Europe, was found with two types of mushroom. The Chinese value mushrooms for their supposed medicinal properties as well as for food. Ancient Romans and Greeks, particularly the upper classes, used mushrooms for culinary purposes Rice is a major food staple and a mainstay for the rural population and their food security. It is mainly cultivated by small farmers in holdings of less than one hectare. Rice is also a wage commodity for workers in the cash crop or non-agricultural sectors. Rice is vital for the nutrition of much of the population in Asia, as well as in Latin America and the Caribbean and in Africa; it is central to the food security of over half the world population.

Bread is made using rice flour. Rice may be made into congee (also called rice porridge or rice gruel) by adding more water than usual, so that the cooked rice is saturated with water, usually to the point that it disintegrates. Rice porridge is commonly eaten as a breakfast food, and is a traditional food for the sick. Rice flour can also be used as a thickening agent for soups and stews as well as tempura batters for frying vegetables, chicken and more Rice flour can be used to make confections like rice cakes, macaroons and some types of buns due to the texture and flavour it lends the finished products. It is also used for dusting confections in a manner similar to powdered sugar.[5] Since rice flour lacks gluten, a component required for firm wheat bread, it can be used to make cakes, muffins, and other sweet baked goods. However, it is most frequently used to make sweet breads. It is frequently mixed with other non-wheat flours to get the desired consistency and works well in lighter muffins and cakes. Use a recipe designed expressly for rice flour for the greatest results when using it in baking because, in most circumstances, it cannot be substituted for conventional flour. Rice flour is a great alternative to all-purpose flour if you're out or searching for a gluten-free option, and unlike wheat flour, it's simple to create your own at home. Whether your goal is to cut down your grocery budget or simply try something new. Let's go through some more advantages of rice flour.

Material and Method

3.1 Nutritional Profiling of Developed Product

The nutritional qualities of pancake produced from quinoa, soy flours and amaranth blends enriched with spirulina was carried out using standard procedures. The proximate analysis was carried out according to the **AOAC 2015**.

3.1.1 Determination of moisture

The moisture content was determined by oven drying method. The sample of 5gm were crushed and dried in an oven at 75-80^{o}C to constant weight. After cooling in desiccators, the sample was weighed again. The loss in weight was recorded as moisture content.

$$\textbf{Moisture (\%)} = \frac{W1 - W2}{W1} \times 100$$

Where,

W1= initial weight of bottle with sample before drying.

W2= Final weight of the sample after drying

Figure 3.1.1 Weighing of sample for moisture determination

3.1.2 Determination of ash

Ash content can affect different characteristics of food including physiochemical and nutritional properties. Determining the ash content in food samples is part of the proximate analysis necessary for nutritional evaluation. This ensures the safety of foods, making sure there are no toxic minerals present. Following steps were involved in the ash determination: -Crucible preparation ,Sample preparation ,Combustion/ Burning, Taking final weight and Calculation

$$\text{Ash\%} = \frac{W_2 - W_1}{W_s} \times 1000$$

Figure 3.1.2 Sample turned into ash after keeping in muffle furnace

3.1.3 Determination of fat

Soxhlet extraction method was used for the estimation of fat. First of all, rinse all the glass apparatus by petroleum ether and dry it in the oven at $102^{O}C$ and after removing it keep in a desiccator. Weigh 5 gram of the grounded and dried sample and place it in the thimble. Place the thimble in the soxhlet extractor. Take a 150 ml round bottom flask and clean it and fill the flask with 90 ml petroleum ether. Place the whole setting on a heating mantle and allow the petroleum ether to boil. Continue the extraction process for several hours, almost 6 hours. Remove the condensing unit from extraction unit and allow the sample to cool down. Finally, it removes the entire lipid. Place the sample in the oven and after removing it place in the desiccator. Take the weight of the sample. As a result, we get a defat sample. The final calculations were done using the formula: -

$$\textbf{Crude fat \%} = \frac{W_2 - W_1}{W_s} \times 1000$$

Figure 3.1.3.a Soxhlet method

Figure 3.1.3.b Weighing the extracted fat of thimble

3.1.4 Determination of protein

Weigh quickly about 1-2 gm of the sample and transfer to a 500 or 800 mL Kjeldahl flask taking care to see that no portion of the sample clings to the neck of the neck of the flask. Add 0.7 gm of Mercuric oxide, 15gm of the Potassium Sulphate and 40 mL of concentrated sulphuric acid {Mercuric oxide is added to increase the rate of organic breakdown during acid digestion. Because of environmental/safety concerns over handling and disposal of mercury, copper sulphate can be used. This is important for safety point of view as mercury vapours might escape into the environment during the distillation process. Also , Missouri catalyst tablets known as Kjedahl tablets (Composition: 48.8% Sodium sulphate & 0.3% copper sulphate) can be used}

Calculate protein as = N×6.25

$$\text{Protein on dry wt. basis} = \frac{\text{protein content} \times 100}{\text{100- moisture content}}$$

3.1.5 Determination of crude fibre

The total dietary fibre content was content was estimated by AACC method 33-05-01 and AOAC Method 985.29 .Two gram of sample was accurately weighed. 200 ml of 0.255 N H SO2 4 was taken in a 600 ml lipless beaker. It was placed on an electric heater and kept a suitable condensing flask (round bottom) over the beaker. The condensing flask was fixed well. The condensing flask was filled with cold water. Now the heater switched on. The condensing flask was replaced and continued to heating. The residue was digested in the boiling NaOH for a period of 30 minutes. . After 30 minutes, the condenser was removed; the contents of the beaker were transferred to a filtering funnel. The crucible was placed in preheated hot air oven (110ºC) over night. This was to drive off the moisture completely. After complete drying, the crucible was cooled in desiccator. It was weighed along with the residue.

$$\text{Crude fibre\%} = \frac{W_1 - W_2}{W_s} \times 100$$

3.2 Transform infrared spectroscopy (FTIR)

Fourier Transform-Infrared Spectroscopy (FTIR) is an analytical technique used to obtain an infrared spectrum of absorption or emission of organic (and in some cases inorganic) materials. The FTIR has been supplemented with an accessory called Attenuated Total Reflectance **(Stalder et al.)** to enhance the use and application of the instrument in way that with this facility any form of material, i.e. The samples' FT-IR spectrum was monitored by Fourier Transform Infra-Red Spectrometer (FTIR), Model: Nicole 6700, Make: Thermo-Scientific, USA, to assess functional groups present in the film samples. The analysis was carried out with 16 scans of 4000-500 cm^{-1} in each sample, with a 4 cm^{-1} spectral resolution.

3.3 Elemental analysis through EDS (Energy dispersive X-ray spectroscopy) & SEM (**Scanning electron microscopy)**

Morphological analysis is done by using SEM-EDX technique. SEM stands (Scanning Electron Microscopy) and EDX (Energy Dispersive X-Ray) Analysis EDX .SEM-EDX analysis was used to determine mineral distribution in millets products. The aim of EDX in present study was to identify minerals in the prepared samples and to compare the mineral composition of MML, ML, and PMU. The SEM-EDX analysis showed that MML and ML had a similar surface texture, with irregular shapes and rough surfaces. PMU, on the other hand, had a smoother surface texture with a more uniform shape. The element composition of the three products was also different, with PMU having higher levels of calcium, potassium, than MML & ML. MML & ML has higher levels of carbon than PMU. These findings suggest that the surface characteristics and element composition of millet products can vary depending on the processing and preparation methods used. Therefore, further research is needed to optimize the processing and preparation of millet products to improve their surface characteristics and nutritional value.

3.4 Examination of packaging capability of candy

3.4.1 Packaging capability

Packaging retains the consistency of produce and draws consumers. Many consumers are likely to assess the product quality of the item. Packaging companies are creating a special item that can be suitable for the type of product. Companies carry out a lot of testing to find the best ideas for practical products that can protect the product from chemical reactions, light and dust. Inappropriate food packaging influences the quality and flavour of a product. The packaged food is free from contaminants and enhances the longevity of a food product. Food goods are packaged in the containers in such a way that they stay secure during transport.

Result and Discussion

4.1 Nutritional Profiling of Developed Product

4.1.1 Moisture Content

Moisture content is a key factor to be considered in the selection of natural fibres as reinforced materials to produce new composite materials. The low water content is required, since the high-water content may adversely affect the dimensional stability of the candy powder, particularly, in terms of mechanical performance, formation of porosity,

as well as water holding capacity. The moisture content of mushroom powder, walnut powder and rice powder were found to be 12%, 6% and 10% respectively illustrated in table 4.5.1.2.2. The highest moisture content was detected in corn starch as shown in figure 4.5.1.2.2. An increase in moisture content will increase the biodegradation rate of organic material.

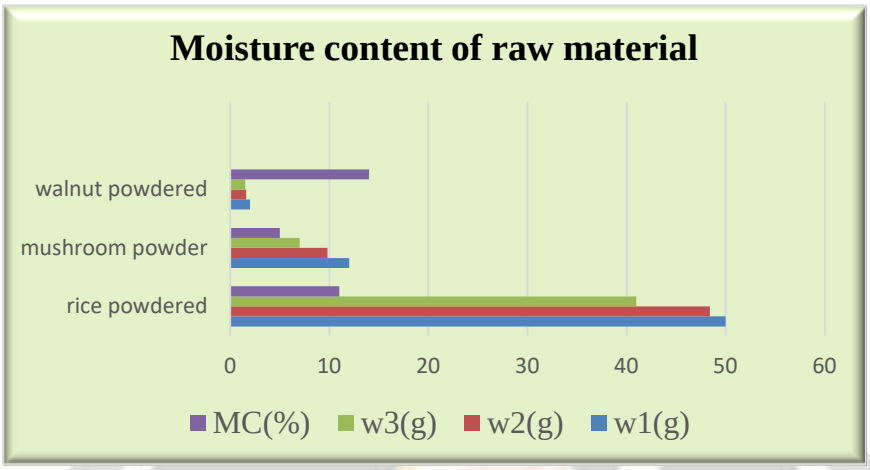


Figure 4.1.1 Moisture content graph

4.1.2 Total ash

In general, the ash content found in this study is for the powder form of ingredients.according to the results rice powder has the maximum ash content where as mushroom has the minimum ash .

Table 4.1.1 - Moisture content of raw material

Raw Sample	W1 (g)	W2 (g)	W (g)	MC (%)
Rice powder	50	48.4	41	11
Walnut Powdered	12	9.8	7	5
Mushroom powder	2	1.6	1.5	14

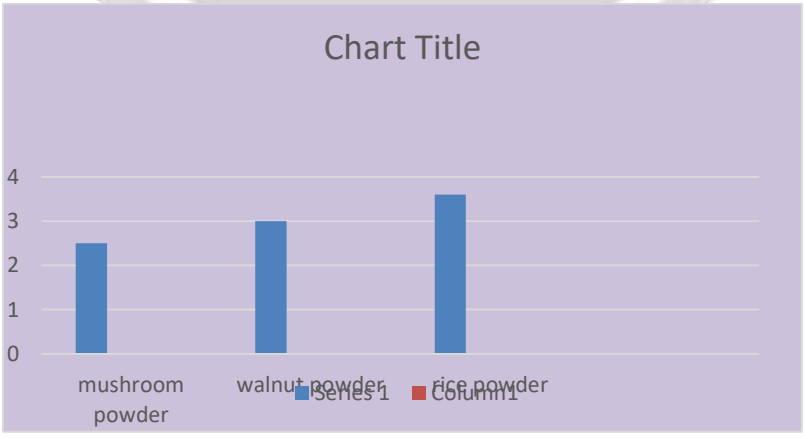


Figure 4.1.2 Graphical representation of ash (%)

4.2 Fourier transform infrared spectroscopy (FTIR)

The FTIR spectra of prepared rice base candy are shown in Figure 4.5.2.2 (1) & (2). As can be seen from the figure, there is a prominent peak at 3375.2 cm^{-1}, the stretching vibration peak of hydroxyl in the molecule. The peak at 2936.2 cm^{-1} of alkyl C–H antisymmetric stretching vibration is the characteristic absorption peak of powder form in the, indicating that was successfully embedded in the starch molecule. A sharp peak appeared in 1660.1 cm^{-1}; C-O bending associated with the OH group. The absorption peak of 1079 cm^{-1} is the stretching vibration peak of C–O in C–O–H of cellulose. The peaks at 1153.8 and 1037.4 cm^{-1} are the C-O-C asymmetrical stretching and C-O stretching of alcohol, phenol and ester groups. C-O-C ring. Vitamins & carbohydrates are observed at 855.7 and 572.3 $cm^{-1.}$ Vibrations of carbohydrates are observed at 855.7 and 572.3 $cm^{-1.}$

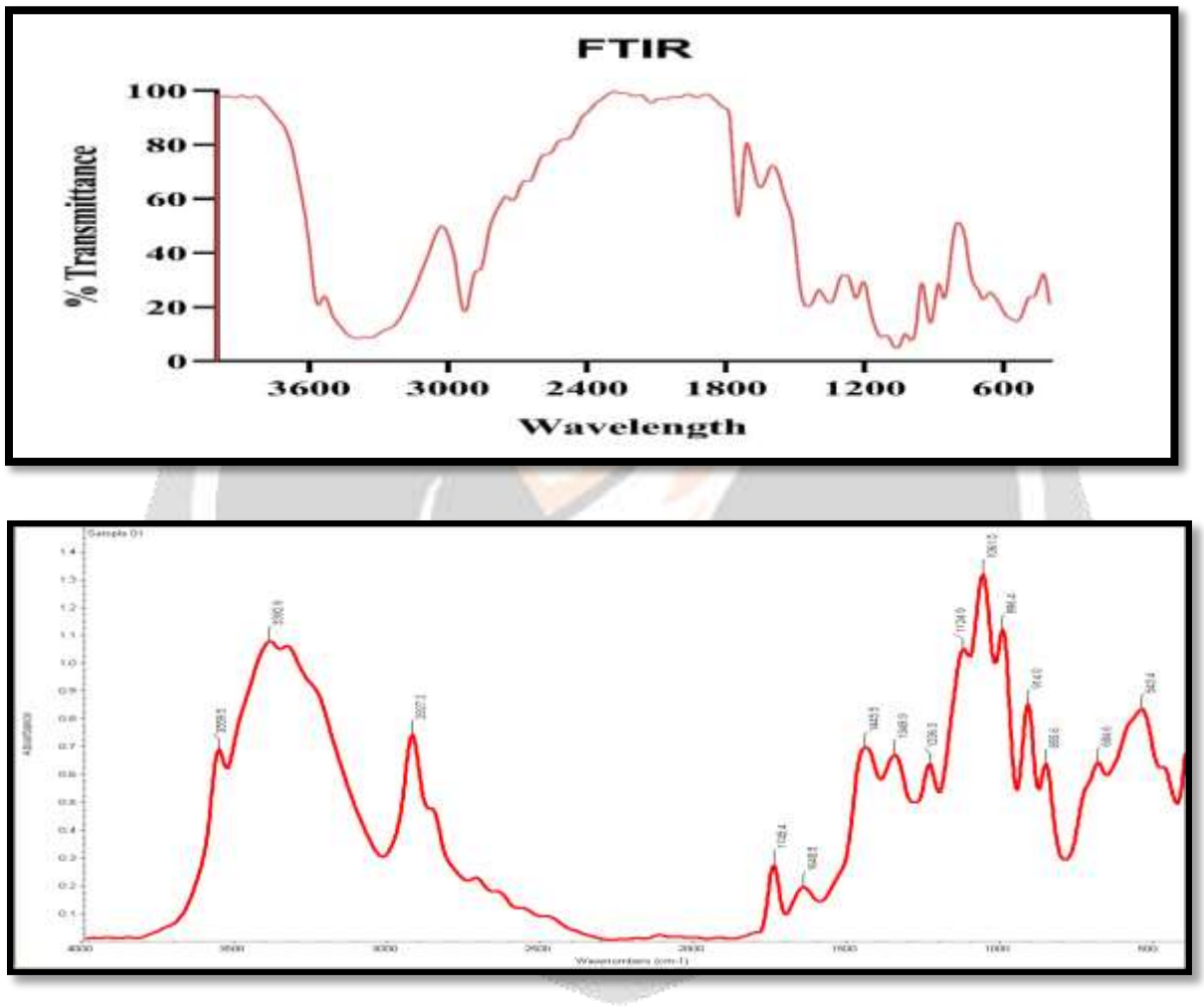


Fig. 4.2 (1) FTIR of (a)corn starch film

4.3 Scanning electron microscopy (Azlin et al.)

The scanning electron microscopy (Azlin et al.) morphology of the surface of the rice base candy at different magnification levels (×200(1), ×1000(2) and ×1,800(3)) are depicted in Figure 4.5.2.4, 4.5.2.5, 4.5.2.6, 4.5.2.7, 4.5.2.8 and 4.5.2.9. The control film showed a compact, even and relatively smooth structure without porosity; also, undissolved powder in addition. In addition, it was observable from the cross-sections of film that the control film

surface was smooth, while the candy film was little bit rough. This phenomenon was due to the rising fiber concentration and apparent fibre.

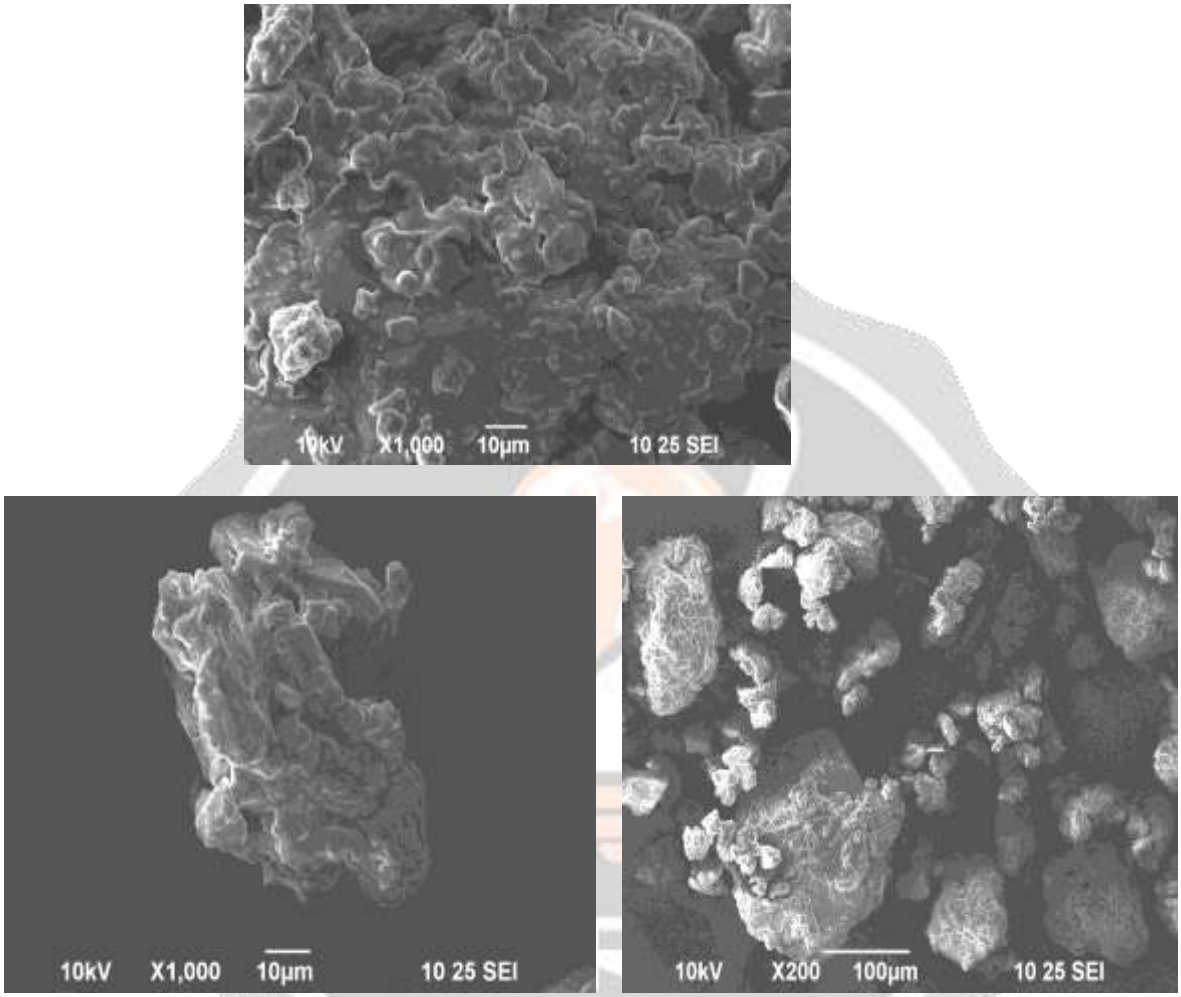
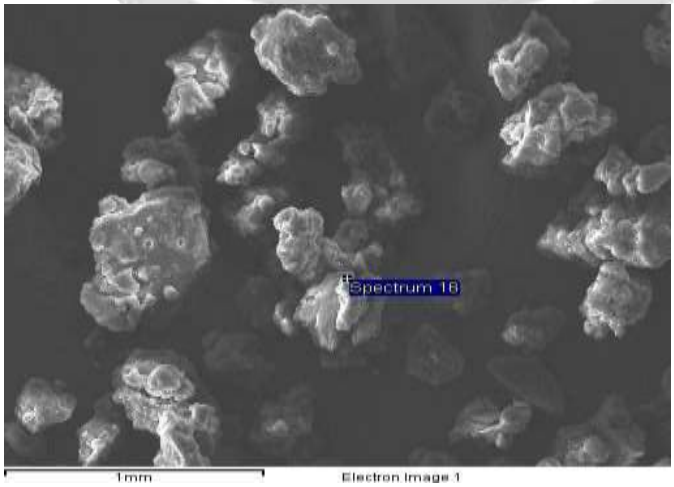


Fig. 4.3 (a)– SEM images of C: Candy at (1) ×200, (2) ×1000, (3) ×1800 level magnification



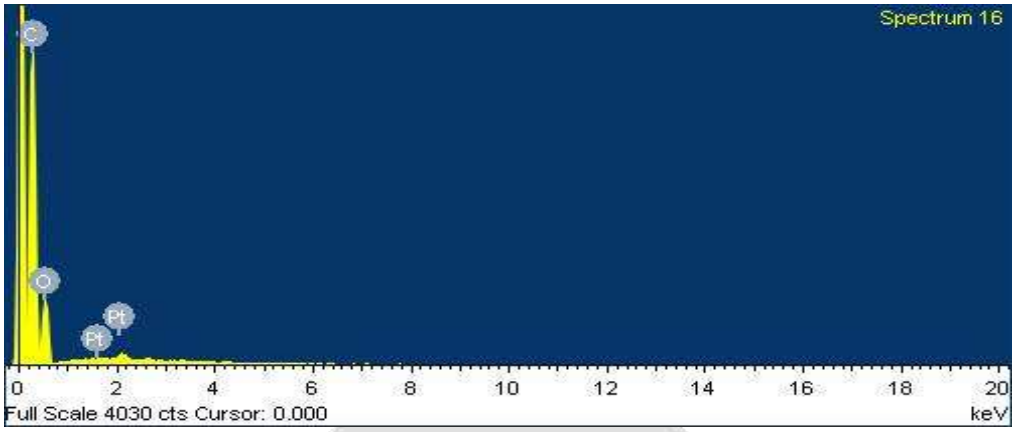
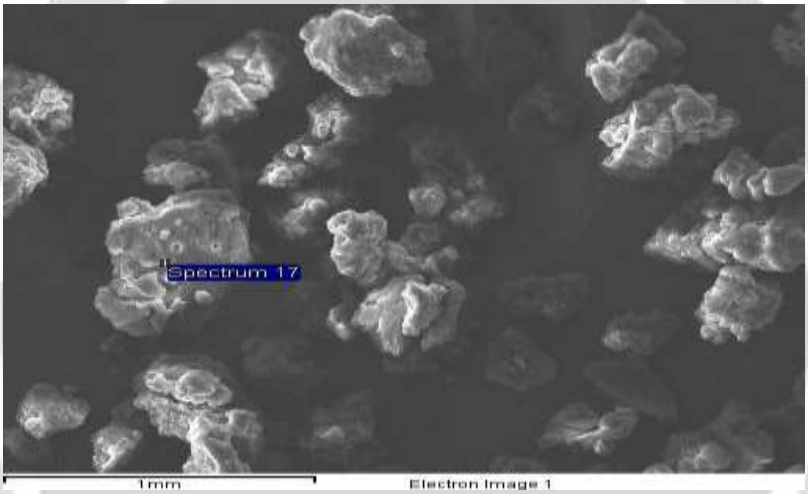


Figure 4.3 (b).11 EDS Spectrum for F1 candy



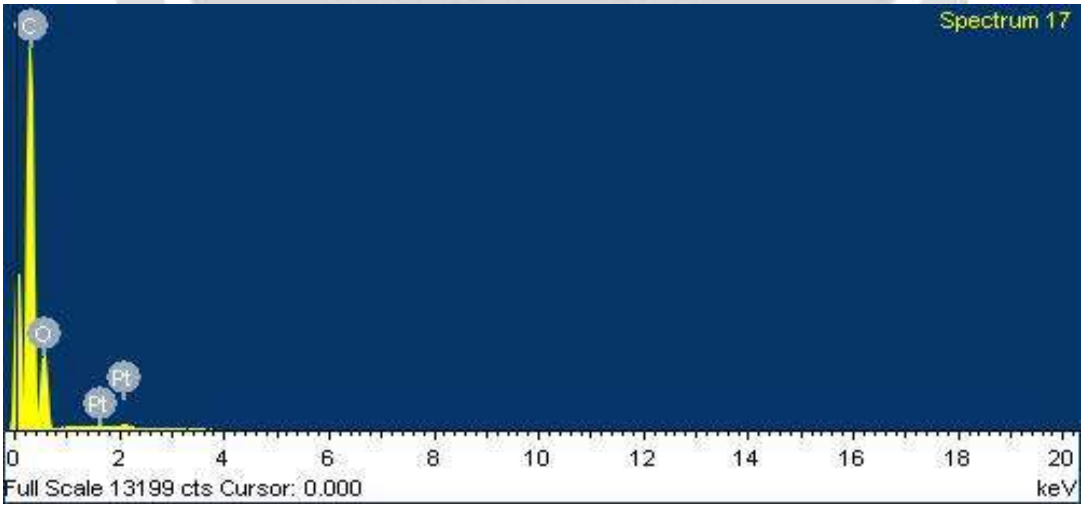


Figure 4.3 (c)11 EDS Spectrum for F2 candy

4.4 Package labelling of rice base candy

Package labelling was done in this study as per Food Safety and Standard (Packaging & Labelling) regulation, 2011. The study used following Mandatory labeling requirements -

- The Name of product
- List of ingredients
- Name and address of the manufacturer
- Net Quantity
- Lot/Code/Batch Identification
- Date of manufacturing or packing
- Best Before and use by Date
- Country of origin
- Instructions for use
- Warning and advisory statements.

The study did not include all the labelling parameters as the product was produced on experimental basis and not for commercial purpose.

Figure 4.4 Packed rice base candy

Conclusion

The creation of rice base candy served as the foundation for the study. The results of this study indicate that an individual nowadays require a lot of daily nutrients and the general acceptance of or like by people indicates that they find the idea and process of creating candy to be appealing. Some people dislike sweetness because they prefer a tangier flavour in their sweets, but overall acceptability demonstrates that the product will satisfy consumers' nutritional demands, which are universally sought for. Walnuts are the major component used for nutritional fulfilment and are well-suited to the recipe. It is prepared to serve as daily sweets for those who are in need and others who enjoy candies.

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References

1. Jain, H. and Jain, I.H., 2001. Learning the Principles of Glass Science and Technology from Candy Making. In *NASA CONFERENCE PUBLICATION* (pp. 169-182). NASA; 1998..
2. Pizzoni, D., Compagnone, D., Di Natale, C., D'Alessandro, N. and Pittia, P., 2015. Evaluation of aroma release of gummy candies added with strawberry flavours by gas-chromatography/mass-spectrometry and gas sensors arrays. *Journal of Food Engineering*, *167*, pp.77-86.
3. Spence, C., Corujo, A., & Youssef, J. (2019). Cotton candy: A gastrophysical investigation. *International Journal of Gastronomy and Food Science*, *16*, 100146.
4. XU, X., REN, S., WANG, D., MA, J., YAN, X., GUO, Y., LIU, X. and PAN, Y., 2021. Optimization of extraction of defatted walnut powder by ultrasonic assisted and artificical neural network. *Food Science and Technology*,
5. Dudekula, U.T., Doriya, K. and Devarai, S.K., 2020. A critical review on submerged production of mushroom and their bioactive metabolites. *3 Biotech*, *10*, pp.1-12.
6. Moonmoon, M., Shelly, N.J., Khan, M.A., Uddin, M.N., Hossain, K., Tania, M. and Ahmed, S., 2011. Effects of different levels of wheat bran, rice bran and maize powder supplementation with saw dust on the production of shiitake mushroom (Lentinus edodes (Berk.) Singer). *Saudi journal of biological sciences*, *18*(4), pp.323-328..
7. Salehi, F., 2019. Characterization of different mushrooms powder and its application in bakery products: A review. *International Journal of Food Properties*, *22*(1), pp.1375-1385.
8. Obidiegwu, M.U., Nwanonenyi, S.C., Eze, I.O. and Egbuna, I.C., 2014. The effect of walnut shell powder on the properties of polypropylene filled composite. *The International Asian Research Journal*, *2*(1), pp.22-29.
9. Pradhan, P. and Satapathy, A., 2022. Physico-mechanical characterization and thermal property evaluation of polyester composites filled with walnut shell powder. *Polymers and Polymer Composites*, *30*, p.09673911221077808.
10. Li, Y., Liu, Y., Tan, H., Zhang, Y. and Yue, M., 2016. Use of Walnut Shell Powder to Inhibit Expression

of Fe2+-Oxidizing Genes of Acidithiobacillus Ferrooxidans. *International journal of environmental research and public health*, *13*(5), p.461.

11. Jeong, C.H., Lee, S.H. and Kim, H.Y., 2022. Analysis of food storage stability of biodegradable containers made of pork skin gelatin polymer with walnut shell powder. *Polymers*, *14*(10), p.1940.

12. Lee, J.C., Kim, J.D., Hsieh, F.H. and Eun, J.B., 2008. Production of black rice cake using ground black rice and medium-grain brown rice. *International journal of food science & technology*, *43*(6), pp.1078-1082.

13. Hafeel, R.F., Bulugahapitiya, V.P., de Zoysa, G.E.D. and Bentota, A.P., 2020. Variation in physicochemical properties and proximate composition of improved and traditional varieties of rice in Sri Lanka. *Journal of Food and Agriculture*, *13*(1), pp.19-32.

14. Park, S.Y., Lee, J.W., Kim, G.W. and Kim, H.Y., 2017. Effect of black rice powder on the quality properties of pork patties. *Korean journal for food science of animal resources*, *37*(1), p.71.

15. Jung, H.W. and Chung, H.J., 2013. Quality characteristics and amino acid content of cookies with GABA-enhanced brown rice.

16. Ibukun, E.O., 2008. Effect of prolonged parboiling duration on proximate composition of rice. *Scientific Research and Essay*, *3*(7), pp.323-325.

17. Juliano, B.O., Bautista, G.M., Lugay, J.C. and Reyes, A.C., 1964. Rice quality, studies on physicochemical properties of rice. *Journal of agricultural and food chemistry*, *12*(2), pp.131-138.

18. Wansink, B., Painter, J.E. and Lee, Y.K., 2006. The office candy dish: proximity's influence on estimated and actual consumption. *International journal of obesity*, *30*(5), pp.871-875.

19. Odebunmi, E.O., Oluwaniyi, O.O. and Bashiru, M.O., 2010. Comparative proximate analysis of some food condiments. *Journal of Applied Sciences Research*, *6*(3), pp.272-274.

20. Ifesan, B.O.T., Olorunsola, B.O. and Ifesan, B.T., 2015. Nutritional composition and acceptability of candy from avocado seed (Persea americana). *International Journal of Agriculture Innovations and Research*, *3*(6), pp.1631-1634.