emergent
Life Sciences Research

Research Article

Comparative evaluation of functional properties of composite flours made from Amaranth, Rice and raw Banana

Salunke Shivam, Genitha Immanuel

Received: 05 August 2022
Accepted: 03 November 2022
Online: 08 November 2022

Authors:
S. Shivam ✉, G. Immanuel
Department of Processing and Food Engineering, Vaugh Institute of Agricultural Engineering and Technology, Sam Higginbottom University of Agriculture, Technology and Sciences,
Prayagraj, (U.P.) – 211007, India

✉ shivam6213@gmail.com

Emer Life Sci Res (2022) 8(2): 162-167

E-ISSN: 2395-6658
P-ISSN: 2395-664X

DOI: https://doi.org/10.31783/elsr.2022.82162167

Abstract

Exploring the functionality of composite flours from Rice, Amaranth and Raw banana for various food products can be advantageous in food industry as it has more benefits. Therefore the purpose of the plan of the current study is to examine the functional characteristics of these composite flours at various proportions. Composite flours were blended in six treatments in the ratio of 100:0:0 (T_0), 0:100:0 (T_{00}), 49:49:2 (T_1), 48:48:4 (T_2), 47:47:6 (T_3) and 46:46:8 (T_4) respectively. The different functional properties of the blend such as water absorption capacity, oil absorption capacity, swelling capacity and foaming capacity were determined. It was revealed that the capacity for water and oil absorption was decreased for T00 and decreased with the addingpercentage of raw banana powder in the flour blend from T_1 to T_4. Also the foaming measurement and swelling measurement of the flour blend ranged between 8% to 14% and 8ml to 17ml respectively. These flours can be used for making the pasta and similar products, because of its high nutritional quality which is beneficial for human health.

Keywords amaranth flour, composite flours, functional properties, raw banana powder, rice flour

Introduction

Evidence of possible health advantages for consumers is an increase in need for processed food with beneficial components for health like soluble fibre. Reduction of several chronic infection, as well as adult-onset diabetes, cancer, cardiovascular illness and various gastrointestinal ailments are few diseases. Amaranth has stabled amino acids, along with the necessary amino acid lysine that is already found in many of grains [1].

The "Amaranth family" is the collective name for the Amaranthaceous family. Currently, it is also referred to as a third millennium crop plant. There are over 400 species in the genus Amaranthus, just a few of which are found throughout the world. According to historical data, the Mayan civilization of south and Central America was the first to domesticate and cultivate Amaranthus some 8000 years ago. The majority of historical evidence indicates that amaranths, also known as *huahtli*, were a staple crop farmed in Mexico during the time of the Aztec civilization [2]. After analysing the flour, starch, and protein concentrations from *Amaranthus cruentus* BRS Alegria, [3] came to the conclusion that they have consider going for usage as food components. Kaur et al., [4] had done research on the variety of amaranth lines' plant, grain, and flour properties. Addressing their physicochemical and functional qualities, the literature has discussed amaranth proteins, starch, and fibre [5]. World's leading food crops, bananas are widely farmed in areas that are tropical and subtropical. The banana fruit is high in dietary fibre, antioxidants like vitamins as well as minerals like potassium, magnesium, and phosphorus [6].One of the novelty to use it is to dry raw bananas and turn them into raw banana flour. The bacterial micro flora in the large intestine may access the resistant starch found in green bananas, which has health benefits like lowering blood sugar. But during ripening this starch reserve decreases due to enzymatic action. Therefore, pasta was produced using raw banana flour [7].

The amount of broken kernels in the rice component can range from 5 to 7 percent, but all of them have nutritional value equivalent to that of whole grains and can be found easily for a reasonable cost. About 7.3 percent of rice is protein, 2.2 percent is fat, 64.3 percentage of its accessible CHO, 0.8 percent is fibre, and 1.4 percent is ash [8]. Since it has a bland flavour, a pleasing white colour, is hypoallergenic, and is simple to digest, rice flour has increased in popularity as a component in the extrusion business [9]. According to Kadan et al., [10], an increasing variety of innovative meals, including tortillas, drinks, prepared meats, dessert, salad flavouring and gluten-free bakery stuffs, now use rice, mainlyrice flour, on account of its distinct effective qualities.

The aim of this study was to appraise the functional attributes of blended flours made from amaranth, rice, and raw bananas in various ratios.

Methodology

Materials

For this investigation, the rice and amaranth flours were purchased from local market of Prayagraj. The raw banana powder was prepared in the laboratory. The experiments were conducted at Department of Processing and Food Engineering, Vaugh Institute of Agricultural Engineering and Technology, SHUATS, Prayagraj.

Raw Banana powder preparation

Raw bananas were procured from the local market in Prayagraj, UP. They were cleaned, peeled and cut to a 2 mm thickness. The slices were dried in a tray dryer (Make-SD electronics and model- SD 100) for 2.5 hours at 60 °C. The dried slices were milled and sieved (100μ). This powdered raw banana was kept for future investigation. Figure 1, shows the flow chart for making raw banana flour

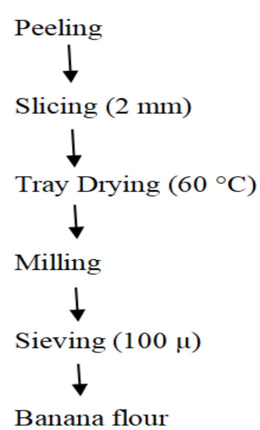

Figure 1. Preparation of raw banana powder

Functional properties

Determinationof swelling capacity

The procedure for calculating swelling capacity was reported by Chandra et al., [11]. One g of flour sample was placed in a measuring cylinder of 10ml capacity. After carefully adding 5 ml of water, the sample's volume was measured. After one hour of standing in water without being disturbed, the sample was measured for the volume it had filled after swelling, and equation 1 was used to calculate it.

$$\text{Swelling Capacity} = \frac{\text{Volume occupied by sample before swelling}}{\text{Volume occupied by sample after swelling}} \ldots\ldots\ldots\ldots(1)$$

Determination of water absorption capacity

Using a variant of the method described by Chandra et al., [11], the flours ability to absorb water was assessed. After standing at ambient temperature (30±2 °C) for half an hour, 10 ml of distilled water were added to 1 g of the sample, and it was centrifuged for half an hour at 3,000 rpm. Calculated from equation 2, water absorption was measured by the percentage of water bound per grams of flour.

$$\text{WAC} = \frac{weight\ of\ sediment\ with\ centrifuge\ tube - wt.of\ centri.tube}{weight\ of\ original\ sample} \times 100 \ldots\ldots\ldots\ldots(2)$$

Determination of oil absorption capacity

Using a modified method Chandra et al., [11] the oil absorption capacity was evaluated. After standing at ambient temperature (30±2 °C) for half an hour, 10 ml of soya oil were added to one grams of the sample. (Sp. Gravity: 0.9092), and the mixture was then centrifuged at 300 rpm for half an hour. Equation 3 was applied to find out the percentage of oil that was bonded to each gram of flour.

$$\text{Oil Absorption Capacity} = \frac{weight\ of\ sediment\ with\ centrifuge\ tube - wt.of\ centri.tube}{weight\ of\ original\ sample} \times 100 \ldots\ldots\ldots\ldots(3)$$

Determination of foaming capacity

Using a modified method of Narayana and Rao [12]. In a measuring cylinder, sample of 1.0 g was added to 50 ml of distilled water. The suspension was blended and shaken for five minutes. Equation 4 was used to calculate the foaming capacity and express the magnitude of the foam after whipping for 30 seconds.

$$\text{Foaming capacity} = \frac{vol.of\ foam\ AW - vol.of\ foam\ BW}{vol.of\ foam\ BW} \times 100 \ldots\ldots\ldots\ldots(4)$$

Statistical Analysis

Unless otherwise noted, each analysis had been done in triplicate. Analyzing variance in one sided (ANOVA) was used to evaluate statistical consequence and findings were reported as the mean standard deviation.

Results and Discussion

When developing new food products, functional qualities of composite flours are important. The functional properties of various flours, such as swelling, foaming, water absorption and oil absorption capacity were studied. The percentages used for the composite flour mix in the treatments below are T_0 = 100%, T_{00} = 100%, T_1 = 49% Rice flour + 49% Amaranth flour + 2% Raw banana flour, T_2 = 48% Rice flour + 48% Amaranth flour + 4% Raw banana flour, T_3 = 47% Rice flour + 47% Amaranth flour + 6% Raw banana flour, T_4 = 46% Rice flour + 46% Amaranth flour + 8% Raw banana flour. Table 1 shows the various functional properties of different composite flours.

Table 1. Functional properties of composite flours

Sample	SC(ml)	FC (%)	WAC (%)	OAC (%)
T_0	11.5±0.5	14.02±0.3	397.7±03	251.3±0.7
T_{00}	8.04±0.5	10.03±0.3	201.8±0.2	198.3±0.3
T_1	13.3±0.5	12.04±0.3	269.9±0.7	253.4±0.4
T_2	11.3±0.3	11.05±0.5	255.7±0.3	234.5±0.3
T_3	9.6±0.5	10.02±0.5	240.05±0.4	220.3±0.4
T_4	8.03±0.1	8.12±0.5	230.07±0.4	203.8±0.4

Mean ± standard deviation.

Values within a column followed by the same superscript letter are not significantly different from each other ($p > 0.05$).

SC=Swelling Capacity, FC= Foaming Capacity, WAC=Water Absorption Capacity, OAC=Oil Absorption Capacity

Swelling capacity

Variations in swelling capacity (SC) are a representation of the amount to which the internal structure of the flour's starch was exposed to the action of water. As the capacity of starch to absorb water molecules and swell is measured by its swelling capacity, which also indicates the level of accessory forces inside starch granules. The range of various flours' swelling capacities was 8.03 ml to 13.3 ml. Table 1 shows that T_4 and T_{00} had the lowest swelling capacity values (8 ml), whereas T_1 had the highest values (13.03 ml). Swelling capacity of blended flours increased with higher levels of rice, green gram and potato flour incorporation ratio and reduced with higher levels of wheat flour [11]. Given that millet flour has a high starch, it is clear that the amount of millet flour has a significant impact on the swelling capacity of blended flours [13]. Because swelling capacity measures how well starch can absorb water molecules and swell, it also provides information about the strength of the associative forces present in starch granules. T_{00} was significantly different from other samples. Swelling Capacity is a result of the product's size expansion when it comes into contact with water [14]. Unripe banana flour has very low water solubility [7], so it can be derived that this is because it has a low absorption capacity, rice and amaranth flour have higher starch contents than banana flour, and as the proportion of these flours decreases, the composite flour's ability to swell also decreases.

Foaming capacity

A protein's ability to create foam determines how much interfacial area it can produce [15]. A particle made up of various gas bubbles that have been trapped in liquid or solid termed foam. Thin liquid films surround tiny air bubbles. According to Table 1, the foam capacity of several flours ranged from 8 to 14 percent. The maximum recorded foam capacity was for T_0 (14.02%), followed by T_{00} (10.03%), T_1 (12.04%) and lowest T_4 (8.12%). According to Kaushal et al., [16], due to its increased protein content, amaranth flour had the maximum foam capacity. Surface tension at the water-air contact may be reduced by protein in the dispersion, thus, protein has always been responsible for creating a continuous cohesive layer covering foam air bubbles, also the amount of protein in the flour affects foaming capacity; since amaranth and rice flour contains more protein than raw banana flour, the amount of amaranth and rice flour in the compound flour would decrease the capacity of foam.

Water absorption capacity

Water absorption capacity (WAC) is the capability of flour to soak water and swell for better food uniformity [17]. As per the research, the relative starch content of amaranth and unripe bananas causes foods to have higher WAC [18]. Table 1 shows information on the capacity of composite flours to absorb water. For all flours, the WAC varied from 202% to 398%. The WAC was found to be highest in treatment T_0 (397.7%), lowest in treatment T_{00} (201.7%), second highest in treatment T_1

(269.9%), and third lowest in treatment T_3 (230.7%). The outcome suggests that the amount of water absorption was afflicted by the addition of amaranth flour. After incorporating millet flour to a blend; the WAC may have increased because of increased amylase leaching and solubility as well as starch crystalline structure degradation. Protein's combined hydrophile and hydrophobe nature allows it to interact with the water in meals [19]. Various protein concentrations, their level of interaction with water, and structural properties may be to blame for the observed difference in various flours [19]. According to the study, increasing the amount of rice flour and amaranth flour in composite flour raises WAC, while increasing the amount of raw banana flour has no effect on WAC alone and decreases the WAC of the other two flours.

Oil absorption capacity

All of the flours had an OAC varying from 198.3 % to 253.4 %, with T_1 having the highest OAC (253.4%), and T_{00} having the lowest (198.3%). The highest OAC of amaranth was reported by Rustagi et al., [20], and T_0 (251.3%), i.e., amaranth flour, showed similar results. Amaranth's high OAC may be a result of its high protein content. According to Rodríguez-Ambriz et al., [21], OAC is mainly caused by the physical entrapment of oil by non-covalent connections within the starch structure and is connected to the hydrophilic nature of starch found in the raw banana flour. It acts as a measure of how quickly proteins bind to fat in food compositions [22]. According to Chandra and Samsher [23], the capacity of wheat proteins to bond with oil is advantageous in food systems where optimal oil absorption is required. According to the study, reducing the amount of amaranth and rice flour causes the OAC of the composite flour to decrease from T_1 to T_4.

Conclusion

In the current study, it was shown that, as the percentage of raw banana powder in the rice and amaranth flour increased from treatment T_1 to T_4, the functional properties that are water absorption and oil absorption capacity decreased. Due to the replacement of raw banana powder for a proportion of the amaranth and rice flours, the foaming capacity of composite flour decreased from T_1 to T_4. By reducing the amaranth flour from composite flour, its protein level falls, which causes a decrease in foaming capacity. Also, the flour mixture's swelling capacity ranged from 8 to 17 ml. For amaranth flour, it was less, and for treatment T_1, it was highest. By replacing raw banana powder for the rice and amaranth flour in composite flour blends, swelling capacity is reduced.

References

[1] K. D. Kaur, A. Jha, L. Sabikhi and A. K. Singh **(2012)**. Significance of coarse cereals in health and nutrition: A review. J. Food Sci. Tech., **51:** 1429-1441.

[2] A. Rastogi and S. Shukla **(2013)**. Amaranth: a new millennium crop of nutraceutical values. Crit. Rev. Food Sci. Nutr., **53:** 109-125.

[3] D. R. Tapiablácido, P. J. Sobral and F. C. Menegalli **(2010)**. Potential of *Amaranthus cruentus* BRS Alegria in the production of flour, starch and protein concentrate: chemical, thermal and rheological characterization. J. Sci. Food Agric., 90: 1185-1193.

[4] S. Kaur, N. Singh and J. C. Rana **(2010)**. Amaranthus hypochondriacus and Amaranthus caudatus germplasm: Characteristics of plants, grain and flours. Food Chem., **123:** 1227-1234.

[5] K. Shevkani, N. Singh, A. Kaur, J. C. Rana **(2014)**. Physicochemical, pasting, and functional properties of amaranth seed flours: effects of lipids removal. J. Food Sci., **79:** C1271-C1277.

[6] K. Kanazawa and H. Sakakibara **(2000)**. High content of dopamine, a strong antioxidant, in cavendish banana. J. Agric. Food Chem., **48:** 844-848.

[7] N. Savlak, B. Türker and N. Yeşilkanat **(2016)**. Effects of particle size distribution on some physical, chemical and functional properties of unripe banana flour. Food Chem., **213:** 180-186.

[8] Z. Zhou, K. Robards, S. Helliwell and C. Blanchard **(2002)**. Composition and functional properties of rice. Int. J. Food Sci. Technol., 37: 849-868.
[9] R. S. Kadan, R. J. Bryant and A. B. Pepperman **(2003)**. Functional properties of extruded rice flours. J. food Science, **68:** 1669-1672.
[10] R. S. Kadan, R. J. Bryant and J. A. Miller **(2008)**. Effects of milling on functional properties of rice flour. J. food Sci., **73:** E151-E154.
[11] S. Chandra, S. Singh and D. Kumari **(2014)**. Evaluation of functional properties of composite flours and sensorial attributes of composite flour biscuits. J. Food Sci. Technol., **52:** 3681-3688.
[12] K. Narayana and M. S. NarasingaRao **(1982)**. Functional properties of raw and heat processed winged bean (*Psophocarpus tetragonolobus*) flour. J. Food Sci., **47:** 1534-1538.
[13] T. A. Dendegh, M. Ukeyima and R. A. Dendegh **(2019)**. Proximate composition, functional and sensory properties of pearl millet, soy flour and baobab fruit pulp composite flour as a complementary food. Asian Food Science J., **8:** 1-11.
[14] J. E. Obiegbuna, J. A. Nwankwo, J. O. Ozue and A. C. Okolo **(2019)**. Evaluation of yield and physicochemical properties of single cereal grain Akamu and Pre-and Post-Processed Multigrain Cereal Akamu Powders. Int. J. Food Nutrition Res., **3:** 29. doi: 10.28933/ijfnr-2019-05-2206.
[15] O. R. Fennema **(1996)**. Water and ice. in Food Chemistry (3rd edn.) (O.R. Fennema, ed.), pp. 17-94, Marcel Dekker, Inc.
[16] P. Kaushal, V. Kumar and H. K. Sharma **(2012)**. Comparative study of physicochemical, functional, anti-nutritional and pasting properties of taro (*Colocasia esculenta*), rice (*Oryza sativa*) flour, pigeonpea (*Cajanus cajan*) flour and their blends. LWT-Food Sci. Technol., **48:** 59-68.
[17] B. I. Offia-Olua **(2014)**. Chemical, functional and pasting properties of wheat (*Triticum spp*)-walnut (*Juglansregia*) flour. Food Nutr. Sci., 16: Article ID: 49237 doi: 10.4236/fns.2014.516172.
[18] J. N. A. Alviola and V. G. Monterde **(2018)**. Physicochemical and functional properties of wheat (*Triticum aestivum*) and selected local flours in the Philippines. Philippine J. Sci., **147:** 419-430.
[19] A. Arnarson **(2019)**. Milk 101: Nutrition facts and health effects. https://www.healthline.com/nutrition/foods/milk.
[20] S. Rustagi, S. Khan and T. Jain **(2022)**. Comparative study of nutritional and functional characteristics of pearl millet, buckwheat, amaranth and unripe banana flours for gluten-free bakery products. Food Res., **6:** 411-419.
[21] S. L. Rodríguez-Ambriz, J. J. Islas-Hernández, E. Agama-Acevedo, J. Tovar and L. A. Bello-Pérez **(2008)**. Characterization of a fibre-rich powder prepared by liquefaction of unripe banana flour. Food Chem., **107:** 1515-1521.
[22] David, O., Arthur, E., Kwadwo, S. O., Badu, E., &Sakyi, P. (2015). Proximate composition and some functional properties of soft wheat flour. Int. J. Inn. Res. Sci. Eng. Technol., **4:** 753-758.
[23] S. Chandra and Samsher **(2013)**. Assessment of functional properties of different flours. Afr. J. Agric. Res., **8:** 4849-4852.