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Physicochemical Properties and Microstructure of Ready-To-Eat (RTE) Breakfast Cereal Made from Popped Pearl Millet, Amaranth Grains and Groundnut Powder

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***Abstract*: The present study was undertaken to develop ready to eat breakfast cereal from popped pearl millets, popped amaranth grains and groundnut powder. Estimation of physio – chemical properties, minerals and microstructure. The grains used in making this cereal are under utilized and packed with nutrition, groundnut powder adds more protein and taste to the cereal. This cereal is sugar – free and is healthy for the elderly and young children. The grains are gluten free good for celiac patients and rich is iron and zinc good for new mothers and anemic patients. Water absorption capacity is good for it to be soft enough to be eaten by elderly. The water absorption capacity absorbed was 1.75 g/g and bulk density observed was 1.86 g/ml. And a pH of 6.3 checked on the starch of the RTE breakfast cereal.**

***Keywords*: Physicochemical properties, microstructure, RTE breakfast cereal, popped pearl millet, amaranth grains.**

1. Introduction

Pearl millet [Pennisetum glaucum (L.) R.Br.] locally known as bajra is an important and most widely grown type of millet in Africa, Indian subcontinent and in the regions having little or no rainfall of the world. Pearl millet is a C4 plant with high photosynthetic efficiency and dry matter production capacity. Pearl millet is a good source of energy, carbohydrate, protein, fat, ash, dietary fiber, iron and zinc. With low prolamin fraction, pearl millet is gluten free grain and is the only grain that retains its alkaline properties after being cooked which is ideal for people with gluten allergy. It contains a relatively higher proportion of insoluble dietary fiber which causes slow release of sugar, thus making the food products suitable for those suffering from or prone to diabetes, has a low glycemic index than wheat. Nutritional evaluation of the popped pearl millet showed significant decrease in phytic acid, a major anti-nutritional factor in pearl millet. Thus, the nutritive popped grain was found to be very good snack. Like popped rice or corn, the popped pearl millet too was found to have potential to be established in the market, especially to derive its nutritional benefits. The exploitation of pearl millet for preparation of ready-to-use products would help in increasing the consumption and thereby nutritional security of consumers. This will not only help in increasing the profitability of its growers but will also help in providing income and employment opportunities in rural area and also contribute to the food basket of the nation in addressing the food security. Grain amaranth has the potential to contribute to improvement in nutrition of populations, especially in developing countries, because of its unique agricultural, nutritional, and functional properties. It is fast-growing, high-yielding, stress-resistant, nutritious, and has nutraceutical properties. Grain amaranth is rich in proteins, lipids, energy, and fiber (Muyonga et al. 2008). Grain amaranth protein is of superior amino acid profile compared to proteins found in most other plant foods. Amaranth grains contain twice the level of calcium in milk, five times the level of iron in wheat, higher sodium, potassium, and vitamins A, E, C, and folic acid than cereal grains (Becker et al. 1981). Grain amaranth has been shown to exhibit antioxidant activity and this has been attributed to its content of polyphenols, anthocyanins, flavonoids, and tocopherols (Klimczak et al. 2002; Escudero et al. 2011). Phenolic content of grain amaranth varies between species and may be affected by environmental conditions (Escudero et al. 2011). The antioxidant activity of phenolics is associated with inhibition of lipid peroxidation (Charanjit et al. 2009). Animal models have shown protective effects of grain amaranth against serum and liver intoxication (Lopez et al. 2011). Amaranth oil has been shown, in animal studies, to lower total serum triglycerides and levels of low-density lipoproteins (Berger et al. 2003; Escudero et al. 2006; Martirosyan et al. 2007). Consumption of grain amaranth has been associated with health benefits in humans, including recovery of severely malnourished children and increase in the body mass index of people formerly wasted by HIV/AIDS (Tagwira et al.2006).

2. Material and Methods

A. *Materials*

Pearl millet (Pennisetum glaucum), amaranth grains (Amaranthus) and groundnuts (Apios americana) were brought

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from the local market in Lucknow city.

B. *Popping and Puffing*

Sand Roasting: All the grains were sun dried before popping and puffing. In sand roasting method, pre-gelatinized cereals are exposed to hot sand, while temperature of sand is about 250°C. Due to sudden thermal gradient, the moisture inside the grains vaporizes and tries to escape through the micropores, expanding the starchy endosperm in size in this process (Chinnaswamy and Bhattacharya, 1983a). The pearl millet grains (100gms) and amaranth grains(100gms) were popped by the mention process. And groundnut(5ogms) was dry roasted on a hot pan.

C. *Preparation of RTE Breakfast*

The roasted groundnuts are grounder in mixer-grinder to make a powder out of it. The popped pearl millet grain and popped amaranth grains are taken in equal quantities that is 100 gm and peanut powder about 50 gm. All these ingredients are mixed together without any added sugar to make this RTE breakfast cereal. This is what makes this a healthier option over the other market cereal brands.

When serving you can add any sweetener as per your requirement and add dry fruits and nuts for added flavor if required and consume it with milk of your choice.

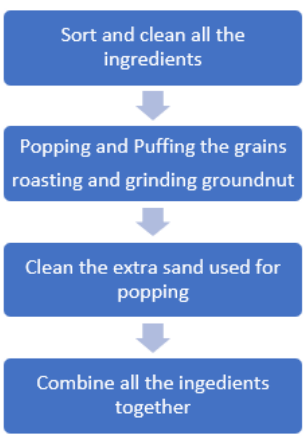


Fig. 1. Flowchart for the preparation of R-T-E

D. *Scanning Electron Microscope [SEM]*

A scanning electron microscope [SEM-EDS] was used for the study of microstructure of R-T-E breakfast cereal. It is a type of electron microscope which produces the image of the sample by scanning the surface of the product [R-T-E breakfast cereal]. They were placed on aluminum cylinder that had a double-sided tape on it that is further followed by coating with carbon. The electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample. The electron beam is scanned in a raster scan pattern, and the position of the beam is combined with the intensity of the detected signal to produce an image.

E. *Physiochemical Analysis*

1) *Water absorption capacity*

The water absorption ability of samples was performed employing Ocloo et al. 1.0g sample was applied to 10 ml of water, and 5 minutes of stirred. The mixture was centrifuged for 30 minutes at 3500rpm, and recorded the amount of supernatant collected. The liquid-absorption potential (percentage) was measured as the discrepancy between the initial water volume applied to the specimen and the supernatant volume expressed in percentage.

2) *Bulk density*

To measure bulk density the volume of 100 g of the product using a measuring cylinder was determined after tapping the measuring cylinder (250 ml) on a wooden plank until no visible decrease in volume was noticed. Based on the weight and volume, the apparent (bulk) density was calculated as suggested by Jones et al. (2000).

3) *pH*

The pH is usually measured with a pH meter, which translates into pH readings the difference in electromotive force (electrical potential or voltage) between suitable electrodes placed in the solution to be tested. Fundamentally, a pH meter consists of a voltmeter attached to a pH-responsive electrode and a reference (unvarying) electrode. The pH-responsive electrode is usually glass, and the reference is usually a mercury-mercurous chloride (calomel) electrode, although a silver-silver chloride electrode is sometimes used. When the two electrodes are immersed in a solution, they act as a battery. The glass electrode develops an electric potential (charge) that is directly related to the hydrogen-ion activity in the solution, and the voltmeter measures the potential difference between the glass and reference electrodes.

The paste of the R-T-E breakfast cereal mix was made by adding 20% distilled water.

Then the pH meter is calibrated and sample mixture's temperature is brought down to room temperature before taking the measurement. Rinse the electrodes and blot do not wipe the electrodes. Dip the electrodes into sample and note the readings. The pH is 6.30

3. Result and Discussion

A. *Mineral Composition of RTE Breakfast Cereal*

RTE breakfast cereal contains an abundance of calcium and least presence of (Pt) when analyzed by Energy dispersive X-ray, which is very effective in identifying the elemental composition of the given sample:

Table 1
Mineral content in RTE breakfast cereal

Element	Weight%	Atomic%
C K	74.23	81.16
O K	22.70	18.63
Pt M	3.07	0.21
Totals	100.00	

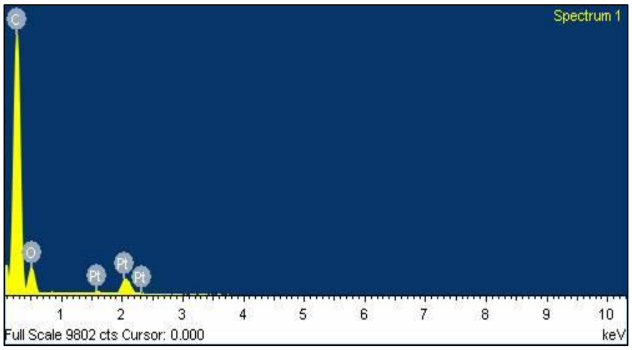
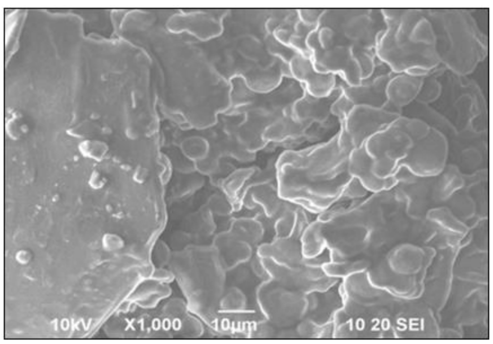
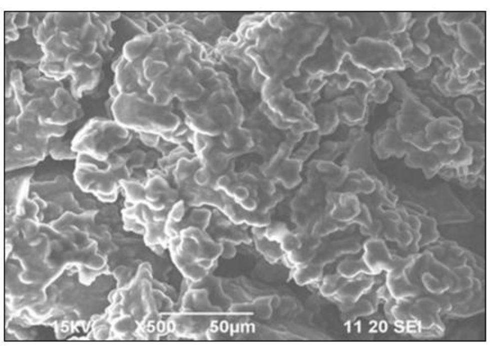


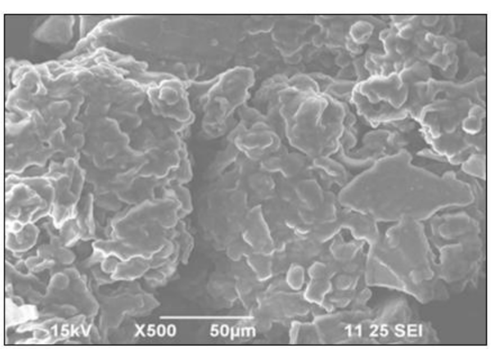
Fig. 2.

B. *Microstructure of RTE Breakfast Cereal*

SEM is used to study the surface morphology, structural integrity as well as determination of the size and shape of RTE breakfast cereal and give an overall three – dimensional image. SEM provides detailed results, in the present study SEM revealed that RTE breakfast cereal components are compact, have grooves and is irregular in shape forming clusters. The shape determines the swelling capacity and in the present study the shape of the component makes it highly absorbent to moisture and retains it for longer duration.







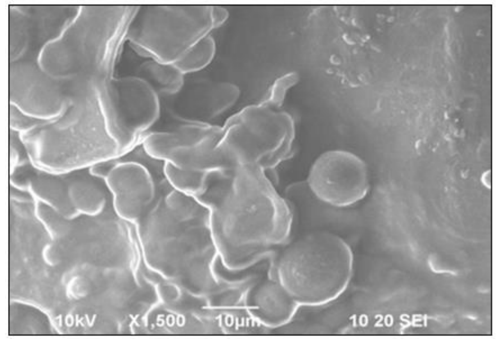


Fig. 3. Microstructure of RTE breakfast cereal

C. *Water Absorption Capacity and Bulk Density*

The more the bulk density the more the water absorption capacity. This means sample is suitable for older people and young babies as they can only eat soft cereal foods.

Table 2
Water absorption capacity and bulk density of RTE breakfast

Functional properties	**Value (dry weight basis)**
Water absorption capacity (g/g)	1.75±0.00
Bulk density (g/ml)	1.86±0.5

4. Conclusion

Ready-to-eat breakfast cereals belong to the category of foods that are inherently stable and have a long shelf life. Thus, the requirements for determining shelf life are quite different from products which have a short shelf life, for example, chilled foods which may only be stable for three to four days. The factors affecting the shelf life are also quite different; deterioration during life will probably not affect the safety of a breakfast cereal but will have an impact on consumer satisfaction. Using under-utilized grains makes this even better to help in the marketing and giving appraisal to the community that works towards the production of these crops and these grains provide us with much nutrients needed for our body to function properly.

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