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Protein Enriched Ragi Flakes

Varsha Keerthi R*, Pavani S

Department of Pharmaceutics, Mallareddy College of Pharmacy, Dundigal, India

Short Communication

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***For Correspondence**

Varsha Keerthi R, Department of Pharmaceutics, Mallareddy College of Pharmacy, Dundigal, India

E-mail: varshakeerthi1990@gmail.com

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INTRODUCTION

Ready-to-eat (RTE) breakfast cereals [1,2] are processed grain formulations suitable for human consumption [3] without further cooking in the home. They are relatively shelf-stable, lightweight, and convenient to ship and store. They are made primarily from corn, wheat, oats, or rice, in about that order of the quantities produced, usually with added flavor and fortifying ingredients. Hot breakfast cereals, on the other hand, are made primarily from oats or wheat; those made from corn or rice is of minor importance, being produced in relatively small quantities. The original hot cereals required cooking in the home before they were ready for consumption, but now some varieties are preprocessed so that they are ready for consumption with the addition of either hot water or milk to the cereal in the bowl.

Breakfast cereal products were originally sold as milled grains of wheat and oats that required further cooking in the home prior to consumption. In this century, due to efforts to reduce the amount of in-home preparation time, breakfast cereal technology has evolved from the simple procedure of milling grains for cereal products that require cooking to the manufacturing of highly sophisticated ready-to-eat products that are convenient and quickly prepared. Breakfast cereals can be categorized into traditional (hot) cereals that require further cooking or heating before consumption and ready-to-eat (cold) cereals that can be consumed from the box or with the addition of milk. Breakfast cereal can be modest but rich source of protein, especially in those products containing protein additives [4], for which the cereal products are excellent carriers. Breakfast cereals are a food that children and adults enjoy, and hence encourage breakfast consumption. Research confirms that breakfast cereals consumers have a more substantial and varied breakfast, and more likely to meet nutritional requirements for nutrients such as vitamins, minerals and fibre than non-consumers. Breakfast cereals make a major contribution to the diet-data shows that they are the leading source of iron in the diet. They are also a major source of vitamins B (about 20%) and provide one tenth of the fibre in the young people.

In summary, breakfast cereals are : Typically low in fat, a good source of fibre and whole grain, taken with milk,good source of calcium, a major contributor of vitamins and minerals to the diet, low in sugar than other breakfast alternatives, nutrient dence but not energy dense, quick and easy.

Protein enriched ragi flakes [5] is a breakfast cereal packed with high nutrients. These nutritious flakes can be mixed with milk or our choice of fruits for a better healthy diet. These breakfasts cereal can be consumed by all age groups except infants. These flakes contain ragi that is superior to rice and wheat in nutritional terms. The watermelon seeds add the value to the ragi flakes. Chocolate flavour makes the children and elders to choose the product. These are the flakes that “balance health with diet”. Hence the present study was carried out for development of ragi flakes enriching with protein rich water melon seeds.

Objectives

1. To select the product through the process of ideation.

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2. To formulate the product enriching the ragi flakes with water melon seed that are rich protein.
3. To develop the standardized product.
4. To test the acceptability of product, through sensory evaluation.
5. To calculate the nutritive value and cost of developed product.
6. To design the labeling and choose the appropriate packaging material for the product.
7. To evaluate the marketing potential through test marketing.

REVIEW OF LITERATURE

A number of different food products have been developed and introduced into the market; consumers are showing interest towards the products having the specific properties in that food. In order to prevent hazards and toxicity by consuming healthy foods, which contributes to prevent degenerative disease?

Hence the relevant literature pertaining to the present study was to develop ragi flakes that are enriched with protein. The literature related to the study was presented under the following.

About breakfast cereals

RTE cereals originated in the United States in the latter part of the 19th century. At first developed and used as healthful vegetarian foods in a clinical context, they soon caught on with the general population, and an entire industry was thereby spawned. Their processing typically involves first cooking the grain with flavor materials and sweeteners. Sometimes the more heat-stable nutritional fortifying agents are added before cooking. Two general cooking methods are employed in the industry—direct steam injection into the grain mass in rotating batch vessels and continuous extrusion cooking [6,7].

Breakfast cereal (or just cereal) is a food made from processed grains that is often eaten as the first meal of the day. It is often eaten cold with a spoon, usually mixed with milk, yogurt, and sometimes fruit, but may be eaten dry. Cereals are often fortified with vitamins. A significant proportion of cereals are made with high sugar content. Many breakfast cereals are produced via extrusion.

Breakfast cereals are a healthy choice for breakfast. The breakfast cereal and oat milling industry provides a large number of varieties of breakfast cereals stretching from traditional breakfast cereals to oat flakes and the different types of mueslis. Breakfast cereals [8] can play an important role in improving the diets and nutritional status of children.

Breakfast cereals [9,10] are a food that children and adults enjoy, and hence encourage breakfast consumption. Research confirms that breakfast cereals consumers have a more substantial and varied breakfast, and more likely to meet nutritional requirements for nutrients such as vitamins, minerals and fibre than non-consumers. Breakfast cereals make a major contribution to the diet- data shows that they are the leading source of iron in the diet. They are also a major source of B vitamins (about 20%) and provide one tenth of the fibre in the young people.

Types of breakfast cereals

Most breakfast cereals **(Table 1)** may be grouped into 12 general categories for discussion of their manufacturing processes:

1. Flaked cereals (corn flakes, wheat flakes, and rice flakes), including extruded flakes **(Figures 1 and 2)**.
2. Gun-puffed whole grains
3. Extruded gun-puffed cereals
4. Shredded whole grains
5. Extruded and other shredded cereals
6. Oven-puffed cereals
7. Granola cereals
8. Extruded expanded cereals
9. Baked cereals
10. Compressed flake biscuits
11. Muesli-type products
12. Filled bite-size shredded wheat

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Table 1: Products available in the market.

Nutrients	Nutrient values
Caloreis	328 kcal
Total fat	1.3 g
Carbohydrates	72 g
Proteins	7.3 g
Calcium	344 mg
Phosphorous	283 mg
Iron	3.9 mg
Source: Nutritive value of Indian foods	

Figure 1: Different breakfast cereals available in the market.

Figure 2: Different ragi flakes available in markets.

HISTORY OF BREAKFAST CEREALS

Breakfast cereals were first created to help people with digestion problems [11]. In the 19th century the usual morning meal in America was rich in meat and poor in fibre, a state of affairs that led to widespread gastric disorders. The better off spent time in sanatoriums trying to find a cure for their problems. Early in the 19th century Dr. James Caleb Jackson invented the first breakfast cereal [12-14] called 'Granula'. Granula didn't stand the test of time, however, as the oven-dried mixture of special flour and water had to be soaked overnight before consumption. But Granula was on J.H. Kellogg's mind when he developed his first breakfast cereals. As superintendent of the Battle Creek Sanatorium, a combined spa and hospital for the rich and famous, he was continuously on the lookout for alternatives to help relieve his patients' gastric problems. His most successful product was a breakfast cereal based on boiled wheat.

On one occasion, in 1894, he left the boiled wheat resting for a day before rolling it. He then baked it as usual. This resulted in a crispy tasty breakfast cereal that was so nice, patients at the sanatorium wanted to continue eating it after they'd left. The world-famous cornflakes were born. And the rest, as they say, is history. A great many techniques to make different breakfast cereals then followed. A tool was invented to shred wheat, hence the shredded wheat cereal we can still buy today. Then a 'puff-

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ing gun' was used to heat up grains into puffy crunchy little balls. And yet another way method was to produce breakfast cereals by extruding cereals under high temperature and pressure. This method was the starting point for every breakfast cereal that is known today. So while cereals may have started out as part of an initiative to help adult digestion, many more people, including kids, soon discovered that breakfast cereals are fun, tasty and easy to eat. It's safe to say that for a great many people of all ages around the world, breakfast cereals have become part of the staple diet.

Technology involved of breakfast cereal

Breakfast cereal manufacturing was one of the earliest commercial applications of extrusion technology and remains one of the most widespread. The flaked and gun puffed cereals are the two categories of of breakfast cereals that are extruded form and extrusion and cooked as well **(Figure 3)**.

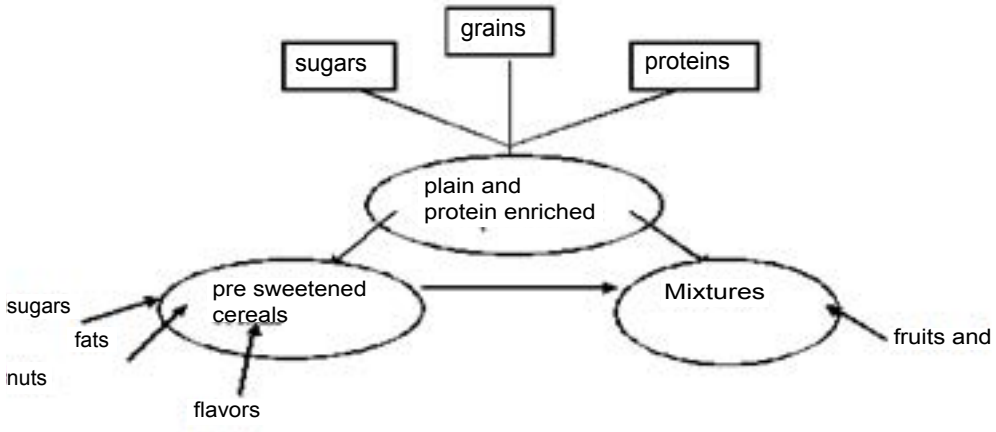

Figure 3: Assembly of complex cereal products from basic plain cereals from which all originate.

Market of breakfast cereals

Some of the major players in this market are Kellogg's, General Mills, Cereal Partners Worldwide, PepsiCo, Post Holdings, Weetabix and others. The company profiles include attributes such as company overview, financial performance, and strategic developments.

People in these countries are switching their breakfast patterns from customary heavy foods to packaged cereals. Increasing workforce and growing concern for wholesome breakfasts is boosting the breakfast cereals market in these two countries. The growing numbers of convenience stores has been increasing the brand visibility of breakfast cereals. In the markets of China and South Korea, around 4,000 new stores were opened in 2011. Convenience stores have increased multifold in China. The Guangdong province, in particular, had over 2000 convenience stores in 2013.

Breakfast cereals can be categorized under two segments: Hot Cereals and Ready-to-eat (RTE) cereals. While the Hot cereals need preparation before they are consumed, the RTE cereals do not need any preparation, and are ready for consumption. The busy lifestyles in the North American and European countries have been the major reason for the popularity of RTE cereals. In these regions, RTE cereals account for more than 85% of the total breakfast cereals consumption. The global share of hot cereals however is expected to increase by 2019, due to the fast growth of breakfast cereals in the Asian countries where people usually start their day with the hot breakfast. The Hot cereals are expected to increase their market share to reach about 18.0% by 2019, in terms of value.

Geographically, the Asia Pacific region is expected to grow at the fastest pace as compared to North America and Europe. By 2019, Asia pacific is expected to have share of around 13% of the market whereas the share of both North America and the Europe is expected to fall during the period.

Breakfast cereal technology has advanced greatly since its origins in the late nineteenth century. The latest innovation in the industry is the twin-screw cooking extruder. The two rotating screws scrape each other clean as they rotate. This allows the dough to move more smoothly than in an extruder with only one screw. By using a twin-screw extruder, along with computers to precisely control temperature and pressure, cereals that usually require about 24 hours to make may be made in as little as 20 minutes.

The global breakfast cereals market, valued at $32.5 billion in 2012, is expected to grow at a compound annual growth rate of 4% for the next several years, reaching $43.2 billion in 2019, according to a new market report from Transparency Market Research.

"The need for convenience and busy schedules of people has been propelling the processed food industry, which includes

breakfast cereals," the market research group said. "Developed nations already have breakfast cereals as part of their regular course of meals. Increasing per capita income in developing countries is further giving the breakfast cereal industry a new dimension to look for."

Geographically, North America, led by sales in the United States, accounted for the largest share in the breakfast cereals market and was valued at $13.9 billion in 2012, according to Transparency Market Research. But the report also points out that declining market in the United States is prompting companies to increase their presence in emerging markets.

The Kellogg Co [15] for instance, last fall announced plans to expand its cereals and snacks facility in Rayong, Thailand, by early 2015. The move is part of its "Project K," which aims to rebuild brands in four key areas: cereal, snacks, frozen foods [16-19] and emerging markets.

Meanwhile, Minneapolis-based General Mills, Inc., though its Cereal Partners Worldwide joint venture with Nestle S.A., in December 2012 opened a new $35 million breakfast cereal manufacturing facility in Malaysia.

The Transparency Market Research report also said the projected growth reflects the trend that people in Asia are switching their breakfast patterns from customary heavy foods to packaged cereals.

"Increasing workforce and growing concern for wholesome breakfasts is boosting the breakfast cereals market in (China and India)," the report said. "The growing number of convenience stores has been increasing the brand visibility of breakfast cereals. In the markets of China and South Korea, around 4,000 new stores were opened in 2011. Convenience stores have increased multifold in China. The Guangdong province, in particular, had over 2,000 convenience stores in 2013."

By 2019, Asia Pacific is expected to have approximately 13% of the total breakfast cereals market, while North America and Europe are expected to see their shares fall, the report note **(Figure 4)**.

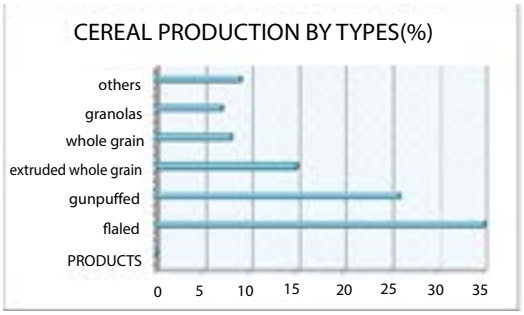

Figure 4: Production of breakfast cereals by types.

Nutrient composition of ingredients

Ragi

Finger millet is a traditional and economical crop rich in protein, iron, calcium, phosphorous, fibre and vitamin content. The calcium content [20-23] is higher than all the food grains.

Ragi has best quality protein along with the presence of essential amino acids Vitamin A [24,25], Vitamin B [26,27] and phosphorous.

Ragi provides highest level of calcium, antioxidants properties [28,29], and phytochemicals [30-32], which makes it easily and slowly digestable.

Ragi has gained importance because of its functional components, such as slowly digestable starch and resistant starch [33-35]. The malted ragi provides nutrients like Vitamin C, phosphorous, lysine and tryptophan **(Table 2)**.

Table 2: Nutrient composition of ragi 100 gms.

Nutrients	Nutrient values
Caloreis	687 k cal
Total fat	52.6 g
Carbohydrates	15.3 g
Proteins	34.1 g
Calcium	100 mg
Phosphorous	937 mg
Iron	7.4 mg
Source: Nutritive value of Indian foods	

Watermelon seeds

Watermelon seeds [36,37] are high in protein and fat, on enriching protein, it can find as a protein source in various food formulations.

Their amino acid composition; high arginine content is indicative of the possession of the medical benefits. Protein of watermelon seeds is almost equivalent to soy. The seeds contain several amino acids including aspartic acid and serine.

The content of watermelon seeds rich in iron, potassium, magnesium, zinc, iron vitamins, fat and calories. Almost half the weight of a watermelon seed is oil which composed of saturated and monounsaturated and polyunsaturated fats including omega- 6 fatty acids.

Watermelon seeds contain lycopene that serves as an anticancer agent [38,39]. The most prevalent B vitamin in watermelon seeds is niacin.

Additionally, flour-like substances made from ground watermelon seeds offer their own unique taste and texture **(Table 3)**.

Table 3: Nutrient composition of water melon seeds for 100 gms.

S.no	Ingredients	Quantity
1.	Ragi	100 g
2.	Water melon seed powder	20 g
3.	Sugar	10 g
4.	Water	63 ml

Studies related to product

Watermelon (*Citrullus vulgaris*) seeds are high in protein and fat, on enriching protein, it can find application as a protein source in various food formulations. Most of the processed foods are generally fortified with micronutrients [40-42]. The effect of the matrix on the mineral bioavailability is highly important and hence investigated. Defatted flour and protein isolate were prepared from watermelon seed meal and chemical composition and functionality was analyzed by standard techniques. Multiple regression analysis was done to study the compositional influence on the mineral bioaccessibility. Invitro digestibility of the protein was good. The seeds were a moderate source of iron and zinc. The percent bioaccessibility of all the minerals were found to correlate (R=0.97–0.99) with the concentration of phytate, tannin and oxalate contents. The seed components exhibited good functionality with good macro and micronutrient density and can find application in many food products.

Folic acid (FA) is a relevant factor in the prevention of a number of pathologies; thus supplementation and/or fortification strategies using FA have been widely introduced as a result. In Spain, there is a lack of reliable data to assess the impact of the increasing number of FA fortified foods. The objective of this work was to evaluate FA fortification levels in breakfast cereal products in Spain. Seventy-three breakfast cereals were analysed for total folate (TF) content. Adequacy was evaluated vs. labelled values (LV), recommended intakes (RI) and tolerable upper intake levels (ULs). Mean TF content ranged from 253 to 427 µg/100 g (76–128 µg/30 g) in different cereal matrix categories. Higher TF content was found in wheat and bran/whole-wheat cereals. As for commercial types, low-fat cereals contained the highest TF levels (445–630 µg/100 g). By consuming these, children (1–9 years old) and women of childbearing age could meet 40–160% and 20–40% of their RIs, respectively, with a standard serving size (30 g). However, children 1–6 years old are at higher risk of excessive FA intake, since low-fat cereals [43,44] contain more than 50% of their ULs. Our conclusion is that overage (the addition of excess vitamin content) is a practice in FA fortified breakfast cereals [45-47]. This could be a potential risk for children, but a benefit for women of reproductive age. Physiological status and age are therefore critical factors to take into account to give pertinent advice in consuming FA fortified foods.

Evaluation of Watermelon seed flour in dough applications. Agricultural Products Research and Technology Ctr., Oklahoma State Univ., 148 FAPC, Stillwater, OK 74078-6055. Watermelon seed offers nutritional and functional benefits on the basis of its oil, protein and fiber composition. One promising use of melon seed flour is in dough applications; currently this has not been investigated. The present work explores the effects of watermelon seed flour (both shell and kernel) on dough rheology. Watermelon seed flour was prepared by screening seeds from puree; washing, vaccum drying, (65°C/20'Hg/12-h), and cracking seeds (manually separating kernel from shell); separately grinding shells and kernels using a Grain-mill; and storing flour in air-tight containers. Flour from shells and kernels, individually and combined, was then mixed at 5, 7.5 & 10% with wheat flour and the dough properties compared to wheat flour [48-50] on a Farinograph (at standard 14% moisture conditions). Dough rheology [51,52] results showing rheological indices, development-time, dough stability and breakdown-time were profiled on a Farinogram. Incorporation of shell flour increased the dough stability and breakdown-time at 5%, stabilized these properties at 7.5%, and decreased them at 10%. Dough development-time was increased slightly at 5% and stabilized at 7.5 and 10%. This was possibly due to the protein and fiber composition of the shell flour. Incorporation of kernel flour alone reduced the dough development-time slightly at all levels while reducing stability and breakdown-time substantially at 5% addition. This was perhaps due to the high oil content within the kernel causing a plasticizing effect. However, shell and kernel flour together (at 5% each) resulted in an overall increase in development-time, stability and breakdown-time. Our studies showed that adding watermelon seed flour at 10% (5% each of both shell and kernel flour) improved the functional properties of wheat flour dough [53,54]. The addition of watermelon seed flour to wheat flour may

offer functional advantages over wheat flour alone and also help in tailoring dough characteristics to selected cereal applications.

Watermelon (*Citrullus vulgaris*) seeds and patent flour from a mixture (Australian and American wheats) were used in this study. Proximate analysis, minerals, tannins and phytic acid contents were carried for wheat and watermelon seed flours. Amino acids profile had been done for watermelon seeds flour. Rheological properties were studied for wheat flour with 0, 5, 10 and 15% watermelon seeds flour. The results of the proximate analysis showed that, ash (2.97%), protein (20.61%), fat (30.50%) and fiber (33.52%) for watermelon seeds flour were significantly higher than for the wheat flour 0.507, 11.05, 1.43, 0.15%, respectively. The wheat flour carbohydrate (76.79%) was higher than the watermelon seed flour (7.31%). Ca, K, Na, Fe ,Mn and Zn (42.09,18.86,33.58,3.42,1.47,3.22mg/100g, respectively in watermelon seeds flour were higher than in wheat flour, but the wheat flour had higher content of Mg (270.55 mg/100g) than watermelon seeds flour (232.41 mg/100g). No significant difference between the two types of flours wheat and watermelon seeds in tannin content 15.0 and 16.7mg/100g, respectively. The phytic acid content of melon seed flour (1445.33 mg/100g) was higher than for wheat flour (126.00mg/100g). Lysine and methionine were the limiting amino acids while glutamic acid was marginal in watermelon seeds flour. The addition of watermelon seed flour affected the rheology of the wheat flour dough as reflected in the farinogram and extensogram. As the percentage of watermelon seeds flour increased, the energy and resistance decreased, but extensibility increased, showing softer dough. The quality evaluation for biscuits made from wheat flour with watermelon seeds flour (15%) addition had the highest spread ratio (10.9). The overall quality evaluation of biscuits made from wheat flour and watermelon seeds flour showed high acceptability, wheat flour blended with 10% watermelon seeds flour showed best biscuits.

METHODOLOGY

The major focus of the present study was to develop the ragi flakes enriched with water melon seeds that are rich in protein then standardized product was obtained. The detailed methodology adopted for development of product is as follows:

Procurement of raw materials

1. Ingredients required

- Ragi flour (malted)
- Water melon seed powder
- Skimmed milk powder
- Powdered sugar
- Chocolate flavor
- Salt
- Water

2. Good quality of skimmed milk powder, sugar, watermelon seeds, ragi seeds was purchased from Pasuparthi supermarket. Chocolate flavour was purchased from wholesale market at Tirupathi.

Pre-processing of raw material

Malting of ragi

The ragi seeds washed with water for 5 times and and soaked in water for 5 hr.

Excess water was drained, seeds were tied in a muslin cloth and 5 kg weight was kept on it. Theses seeds were germinated at 27±3^{0}C for 24 hr and dried in shade for 2 days. The malted ragi seeds were grounded into flour.

Preparation of malted Ragi flour

Ragi seeds (~1kg)
↓
Wash 5-7 time with water
↓
Soak for 5hr in fresh water
↓
Drain of excess water
↓
Tie in a muslin cloth
↓
Keep 5kg weight on the tied cloth

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↓

Keep for 24hr at 27±3°C for germination

↓

Dry in shade for 2 days

↓

Weight and grind to make flour

↓

Pack in airtight plastic container

Preparation of watermelon seed powder

Clean watermelon seeds are taken. Seeds are roasted at low temperature to remove raw flavour. Grind the roasted seeds into powder **(Figures 5 and 6)**.

Figure 5: Ragi seeds.

Figure 6: Malted ragi seeds.

Development of ragi flakes enriched with protein rich water melon seeds

Various trails **(Table 4)** were carried in the preparation of lollipop by changing with the different proportions of key ingredients and also methodology for preparation, the different trails that are conducted:

Table 4: Composition of ingredients in Trail-1.

s	Ingredients	Quantity
1.	Ragi	44 g
2.	Water melon seed powder	9 g
3.	Sugar	13 g
4.	Skimmed milk powder	5.5 g
5.	Chocolate flavour	2 ml
6	Water	22.0 ml

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Trails one

Methodology

- All ingredients like ragi, previously roasted and powdered watermelon seeds, powdered sugar were taken into a bowl.
- To this add water and mix well until soft dough is formed.
- Now extrude the dough by hand extrusion.
- Heat them in oven at 175°C for 10-15 mins.
- Let it cool for two minutes.

In the first trail, flakes were prepared without addition of any flavour, which was not acceptable when subjected to sensory evaluation since the flakes gave a bitter taste.

Trail two

In the second trial **(Table 5)**, the ingredients and methodology that are modified and are as follows:

S.no	Ingredients	Quantity
1.	Malted ragi flour	44 g
2.	Watermelon seed powder	10 g
3.	Sugar	16 g
4.	Skimmed milk powder	6 g
5.	Chocolate flavour	3.5 ml
6.	Water	20 ml

In the second trail 2 ml of chocolate flavour and 5.5 g of skimmed milk powder are added to give a better taste and flavour to flakes. But the flakes were less accepted due to less sweetness and less chocolate flavor.

Trail three

In the second trial **(Table 6)**, the ingredients and methodology that are modified and are as follows

Table 6: Composition of ingredients in Trail-3.

S.no	Ingredients	Quantity
1.	Malted ragi flour	44 g
2.	Watermelon seed powder	10 g
3.	Sugar	16 g
4.	Skimmed milk powder	6 g
5.	Chocolate flavour	3.5 ml
6.	Water	20 ml

In trail three chocolate flavour and sweetness was increased by adding sugar and skimmed milk powder than in trail two. This product was more acceptable due to good flavour and better color. Due to more chocolate flavour the color was more acceptable.

Standardization of "protein enriched ragi flakes"

Various trails were worked out to standardize the ragi flakes. Different trails were made with different in portion of the ingredients and methodology. The prepared product were subjected to sensory evaluation to test the acceptability of ragi flaks. Depend on the sensory evaluation scores the product was highly acceptable and product was made into standard product.

The ingredients and methodology that are used to standardize the product as follows **(Table 7)**.

Table 7: Composition of ingredients for the standardized product.

S.no	Ingredients	Quantity
1.	Malted ragi flour	44 g
2.	Watermelon seed powder	10 g
3.	Sugar	16 g
4.	Skimmed milk powder	6 g
5.	Chocolate flavour	3.5 ml
6.	Water	20 ml

Methodology

The procedure used for standard product is:

- All ingredients like ragi, previously roasted and powdered watermelon seeds, sugar powder were taken into a bowl.
- To this add water and mix well until soft dough is formed.
- Now extrude the dough by hand extrusion.
- Heat them in oven at 175^{0}C for 10-15 mins.
- Let it cool for two minutes.

Various trails were worked out to standardize ragi flakes **(Figures 7-11)**. Different trails were made with different combinations of chocolate flavour and sugar. They were subjected to sensory evaluation to test the acceptability of ragi flakes.

Figure 7: Malted ragi flour.

Figure 8: Mixing of ingredients with ragi.

Figure 9: Ragi dough.

Figure 10: Hand extrusion.

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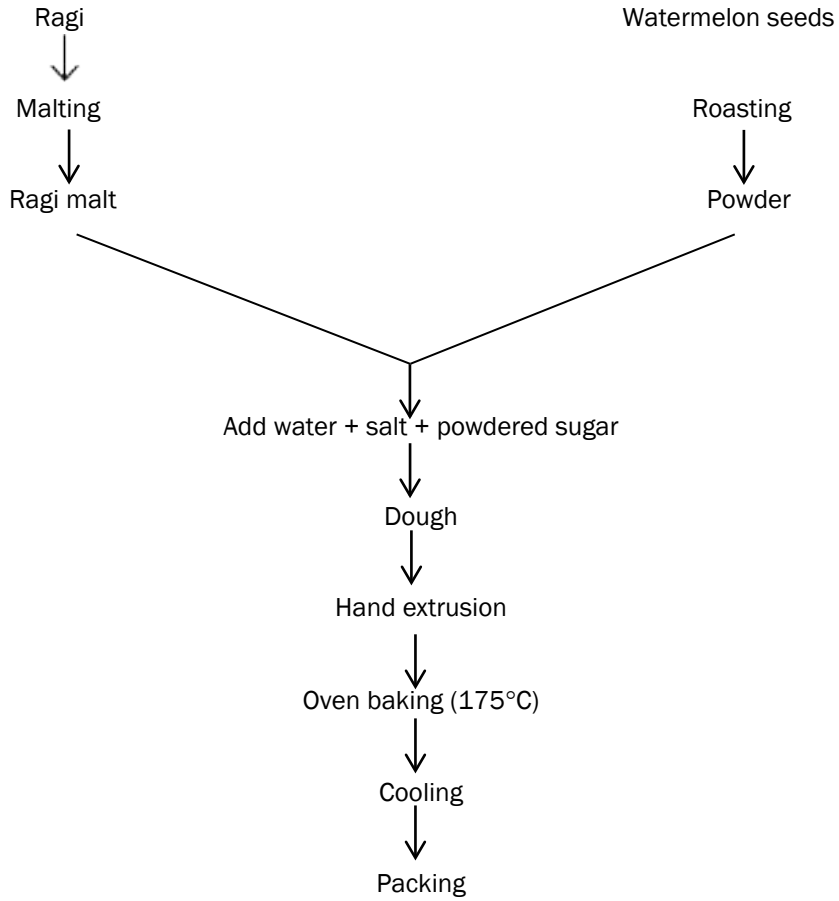
Depending upon the sensory evaluation scores the highest scored product was made into standard product.

Figure 11: Oven toasted ragi flakes.



Sensory evaluation

Sensory evaluation can be defined as the quality of product which is assessed by means of human sensory organs. The evaluation is said to be sensory (or) subjective (or) organoleptic [55,56]. Every time found is eaten, a judgment is made that the sensory quality is a combination of different senses of perceptions coming into play in choosing and eating as food appearance, which can be judged by the eye.

Example: Colour, size, shape, uniformly and absence of defects is of first importance in food selection. In addition to colour, odour, taste and mouth feel certain psychological factors.

The product developed in each trail was subjected to sensory evaluation with the selected panel members. Five point hedonic scales were chosen to test the acceptability, where the panel members express their evaluation according to the scores given for each sensory attributes on the score card. Based on this modification were made in the recipe and was presented again in other trail.

Selection of panel

The first requirement for sensory evaluation was selection of healthy reliable and capable group of panel members. In the present study, sensory evaluation was carried out by two age groups of panel members, i.e. children and adolescents.

There was no sex and age discrimination made among children and adolescents in the selection of panel members. The care was taken that panel members were available throughout the experimental period and they did not have any dislikes towards the product.

Development of score card

Score card was designed based on the various sensory attributes of the product. The score card was pre tested with small sample and redesigned according to the results of the pre-test. The five point hedonic scale was used for the development of score card for various sensory characteristics like.

- Appearance
- Taste
- Color
- Texture
- Flavor and
- Overall acceptabililty

Sensory evaluation of product

Each trail of the product was subjected to sensory evaluation with panel members by giving instructions before evaluation. The score cards were given for each trail.

Assessment of nutrient composition

Nutritive values were calculated by using the Nutritive Values of Indian foods. The nutritive values of the standardized ragi flakes were calculated the essential nutrients such as Carbohydrates [57,58], Proteins [59-61], fat, vitamins [62,63], energy, etc, were calculated.

Packaging

Packaging is an essential component of food processing [64-70] and distribution. Packaging plays a vital role in preservation of food. Different types of packaging materials were used for the packaging of the products.

Functions of packaging

- Protection- from climate hazards i.e., moisture, oxygen, and microbial attack.
- Preservation- the extent of the product could be preserved.
- Promotion-to attract the consumers towards the product

Selection of packaging materials

- Non toxic
- Protect against contamination from microorganisms
- Filter cut harmful UV light
- Provide resistance to physical damage
- Be transparent
- Be easy to open
- Be disposed for easily
- Below cost

For the packaging of the standardized prepared ragi flakes, flakes are sensitive to moisture and its ingress results in softening and microbial spoilage.

They are packed in polythene and polypropelene film poches, flakes are packed in duplex board cartons overwrapped with cellophane.

Labeling

After packaging was done, the product was labeled. The proper labeling was done to identify characteristics of the product which are helpful for easy grading to consumer about product quality.

Once packaging was done properly the product was labeled the following specifications **(Figure 12)**.

- Product name:

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- Brand name:
- Net weight:
- Price:
- Ingredients:
- Directions:
- Nutritional information:
- Storage condition:

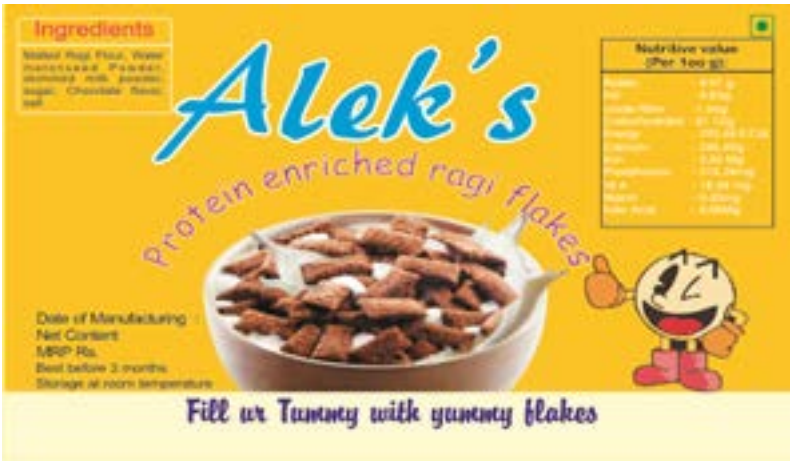

Figure 12: Label design.

Date of manufacture

The standardized and prepared ragi flakes were labeled by containing the above specifications. The labeling was done to the each ragi flakes separately.

Pricing

The product price is estimated by considering the investment on raw materials processing charges including fuel, cost, and manpower, packaging materials [71] and labeling cost. A margin of minimum 10% marginis allowed and according. Calculate for the standardized product later the prices is distributed based on net weight or individual units weight.

The cost of the price calculated or below cost estimated for 1kg/1liter

Product margin in @10% =10x/100

Total estimated cost /kg/lit: x + 10x/100

Cost of the marketing product net weigh

According to the above mentioned formula the price of the product were calculated by considering the investment on raw materials [72-74], processing charges including- fuel cost, manpower, packaging materials, other auxiliary material and labeling cost per unit of ragi flakes and also a carton of ragi flakes, a carton contains six boxes and in each box 12 lollipops were placed.

Test marketing

The marketing is predictive research food for new product innovation. It was mathematical models to project fare cost of sales and market shares are well so to make recommendations for improvements pricing advertisements and promotion. The perceived risk of introduction of new product in the market. The cost of marketing and determines the method of research formats and method of assessment.

The product was prepared in large quantities; 1.2 kg's during the test marketing.

RESULTS AND DISCUSSIONS

The present study was planned to develop ragi flakes enriched with water melon seeds rich in protein, the standardized and developed product was subjected to sensory characteristics like color, taste, flavor, texture and overall acceptability were evaluated for each trail and nutrient composition of the product was calculated. The results obtained in the present study were discussed under the following heads.

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1. Standardization of the product
2. Sensory Evaluation of the product
3. Nutrient Composition
4. Packaging
5. Labeling
6. Pricing

Standardization of the product

Three trails were carried out for the standardization of the product. The variation between these was based on the amount of addition of sugar and chocolate flavour to the flakes. The formulated products were subjected to the scores obtained, the product was standardized. Trail three was well accepeted by the panel members, which is prepared with 16 gms sugar and 3.5 ml chocolate flavor **(Table 8)**.

Table 8: Composition of ingredients in various trails.

S.No	Ingredients	Quantity			Standardized product
		Trail-1	Trail-2	Trail-3	
1	Malted ragi flour	100 gms	44 gms	44 gms	44 gms
2	Water melon seed powder	20 gms	9 gms	9 gms	10 gms
3	Sugar	10 gms	13 gms	16 gms	16 gms
4	Skimmed milk powder	_	5.5 gms	6 gms	6 gms
5	Chocolate flavour	_	2 ml	3.5 ml	3.5 ml
6	Water	63 ml	22 ml	20 ml	3.5 ml

The data in the above table represents that the ingredients used based on sensory evalauation modifications were carried out based on the sensory evaluation conducted.

The trail one was prepared without addition of any flavour which gave a bitter taste. Hence trail two was carried out in order to bring changes in the product. In trail two chocolate flavour amd skimmed milk powder were added to improve flavour and color of the product. When subjected to sensory evalaution the color and sweetness of the product was not acceptable hence trail three was carried out. In trail three the amount of chocolate flavour and sugar was increased. The trail three was highly acceptable in all sensory attributes. Based on these trails standardized product was prepared.

Sensory evaluation

Ragi flakes were evaluated for color, flavor, taste, texture, crispiness and overall acceptability. The ragi flakes sample was presented to the judges in the midmorning in white plates in sensory evaluation laboratory, Foods Lab, Department of Home Science, S.V University.

Sensory scores of ragi flakes: The ragi flakes were subjected for organoleptic evaluation by different judges and results are tabulated **(Table 9)**.

Table 9: Sensory evaluation of ragi flakes in various trails.

S.no	Sensory attribute	Trail -1		Trail – 2		Trail – 3		Standardized product	
		Children	Adoles-cents	Children	Adoles-cents	Children	Adoles--cents	Children	Adoles-cents
1	Appearance	4.20	4.1	4.25	4.2	4.45	4.3	4.45	4.4
2	Color	4.25	4.12	4.35	4.23	4.40	4.32	4.40	4.5
3	Texture	4.21	4	4.25	4.24	4.50	4.5	4.50	4.6
4	Flavor	4.24	4.2	4.28	4.28	4.55	4.5	4.55	4.56
5	Taste	4.00	4.12	4.30	4.3	4.80	4.4	4.80	4.56
6	Overall Acceptability	4.25	4.2	4.30	4.35	4.60	4.56	4.60	4.65

The data in table revealed that sensory scores given by children for the attribute appearance of trail-1, trail-2, trail-3 and standardized product were 4.20, 4.25, 4.45 and 4.45 respectively. And by the adolescents were 4.1, 4.2, 4.3 and 4.4 respectively **(Figure 13)**.

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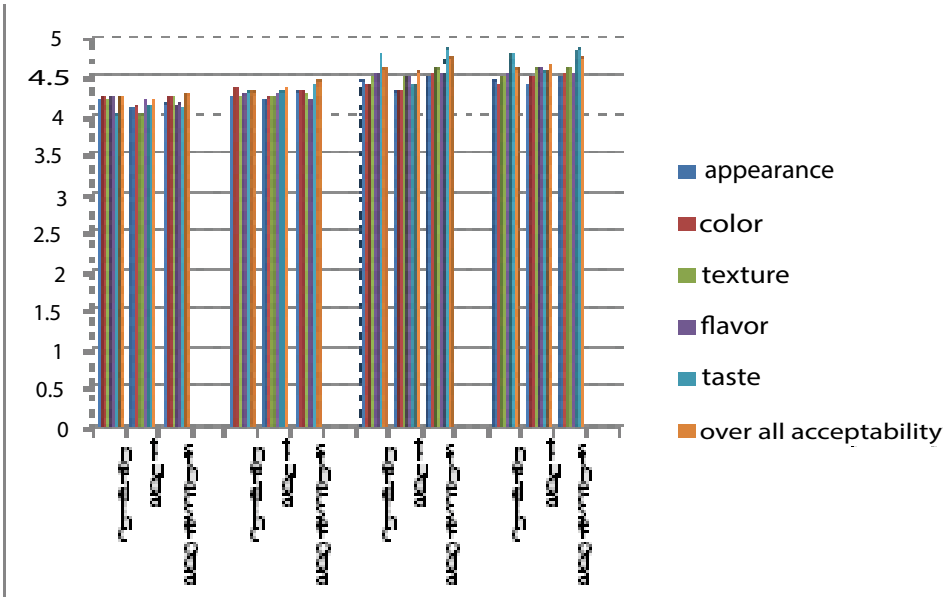

Figure 13: Sensory scores of ragi flakes at different trails.

The sensory scores given by children for the attribute color of trail-1, trail-2, trail-3 and standardized product were 4.25, 4.35, 4.40 and 4.40 respectively and by the adolescents were 4.12, 4.35, 4.40 and 4.40 respectively.

The sensory scores given by children for the attribute texture of trail-1, trail-2, trail-3 and standardized product were 4.21, 4.25, 4.50 and 4.50 respectively and by the adolescents were 4, 4.24, 4.55 and 4.50 respectively.

The sensory scores given by children for the attribute flavor of trail-1, trail-2, trail-3 and standardized product were 4.21, 4.28, 4.55 and 4.55 respectively and by the adolescents were 4.2, 4.28, 4.5 and 4.56 respectively.

The sensory scores given by children for the attribute taste of trail-1, trail-2, trail-3 and standardized product were 4.00, 4.30, 4.80 and 4.80 respectively and by the adolescents were 4.12, 4.3, 4.80 and 4.80 respectively.

The sensory scores given by children for the attribute overall acceptability of trail-1, trail-2, trail-3 and standardized product were 4.25, 4.30, 4.60 and 4.60 respectively and by the adolescents were 4.2, 4.30, 4.60 and 4.65 respectively.

In the third trail all the sensory attributes were good. Hence the product prepared in this trail was considered as standard one.

Nutrient composition

Nutritive values were calculated by using the nutritive value of Indian foods. The essential nutrients were calculated for ragi flakes **(Table 10)**.

Table 10: Calculated nutritive value as per standardized composition.

Name of the product	Quantity	protein	Fat	Crude fibre	CHO	Energy	Ca	Fe	Ph	Vit-B1	Vit-B2	Vit-A
Malted ragi flour	44 g	3.212	0.5	1.584	31.68	144.32	151.3	1.71	124.5	0.184	0.083	18.48
Water melon seed powder	10 g	3.41	5.2	0.08	0.45	62.8	10	0.74	93.7	-	-	-
Sugar	16 g	0.0161	0	-	15.93	64.07	1.93	0.024	0.161	-	-	-
Skimmed milk powder	6.0 g	2.28	0.06	-	3.06	21.42	82.2	21.42	60	0.02	0.098	0
TOTAL	76 g	8.918	5.8	1.66	51.12	292.68	245.4	2.56	278.8	0.211	0.18	18.48

The data in the table reveals about the nutrient composition [75,76] of the standardized prepared ragi flakes, where the quantity taken for the preparation was 100g approximately and the total values obtained, Energy: 292.68 kcal, Proteins: 8.9181 g, Carbohydrates: 51.12 g, Fat: 5.83 g, Calcium: 245.59 mg, Iron : 2.56, Phosphorous: 278.38, Vit-A: 18.48 mg, Vit-B1: 0.211 mg, Vit-B2: 0.54 mg.Nutritive values per 100 g of the product was calculated as follow **(Table 11).**

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Table 11: Nutrient composition per 100 gm of ragi flakes.

Nutrient	Approx for (100 g)
Energy	292.68 Kcal
Carbohydrates	51.129 g
Total fat	5.83 g
Protein	8.91 g
Crude fibre	1.66 g
Calcium	245.49 mg
Iron	2.56 mg
phosphorous	278.38 mg
Vit-A	18.48 mg
Vit-B1	0.211 mg

Nutritive values per 100 gm of the product was calculated for the nutrients such as energy, protein, carbohydrate, fat, calcium, iron, phosphorous, vitamin A, vitamin B1, vitamin-B2 and was calculated and results were tabulated in table.

Packaging

Packaging is an essential component of food processing and distribution. Packaging plays a major role in the preservation of food materials by different types of packaging materials for different types of foods, there are several other functions of packaging. For the standardized and developed product the suitable packaging materials used, thermforms.

Labeling

Food labeling is an essential component in all food processing industry. Labeling information is important for both economical and health reasons. A good labeled product gives the whole definition of the prepared product. The labeling is information of the ragi flakes as follow:

Brand name : ALEK,S

Product Name : Protein enriched ragi flakes

Net Weight : 23 g

Ingredient: Malted ragi flour, water melon seed powder, sugar, skimmed milk [77,78] powder chocolate flavor, salt

Price : 12/-

Nutritional Information:

Date of Manufacture:

Best before: 3 months

Label design:

Nutrient	Appox (100gm)
Energy	292.68 KCAL
Carbohydrates	51.129 g
Total fat	5.83 g
Protein	8.91 g
calcium	245.49 mg
Iron	2.56 mg
phosphorous	278.38 mg
Vitamin-A	18.48 mg
Vitamin-B1	0.21 mg
Vitamin-B2	0.18 mg

Pricing

The product price is estimated by considering the investment on raw materials processing charges including fuel, cost, and manpower, packaging materials and labeling cost **(Table 12)**. A margin of minimum 10% margin is allowed and according. Calculate for the standardized product later the prices is distributed based on net weight or individual units weight.

The cost of the price calculated or below cost estimated for 1kg/1liter

Product margin in @10% =10x/100

Total estimated cost /kg/lit: x + 10x/100

Cost of the marketing product net weigh

According to the above mentioned form, the price of product was calculated by considering the investment on raw materials, processing charges including fuel cost, man power, packaging material, other auxillary material and labeling per unit of ragi flakes and also a carton of ragi flakes. A box of contains 100gms of product and carton contained 10 boxes.

SUMMARY AND CONCLUSION

Breakfast cereals are foods that can be consumed by all the age groups [79-81]. In the present market the breakfast cereals available are carbohydrate rich and are available in different flavours. Since the health concerns among the people has increased manufacturers are looking for the breakfast cereals which balance the "health with diet" [82-89]. The watermelon seeds are consumed around the world since they are rich source of proteins. It was studied that the protein of watermelon seeds equal to the soy protein [90-96]. Hence the the ragi flakes are prepared by enriching them with protein rich watermelon seeds [97,98].

Ragi flakes were standardized after conducting many trails in the laboratory [99,100]. In the first trail argi flakes were subjected to sensory evaluation, the color and appearance was good but the flakes gave a bitter taste. The second trial was conducted in order to bring familiar changes in the product; sweetness was not accepted when subjected to sensory evaluation. In the third trail all the sensory attributes were good and highly acceptable. Hence the ingredient composition and procedure of third trial was standardized to develop the protein rich ragi flakes. The sensory evaluation results revealed the ragi flakes were more accepted in all sensory attributes of the standardized product. Sensory evaluation was carried out by children and adolescents were as panel members. Hence the present study was concluded that the water melon seeds can be used for enrichment of ragi flakes.

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