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Development and assessment of healthy multigrain biscuits of wheat flour with pearl millet, maize and buckwheat composite flours

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Abstract

The present investigation is an attempt to formulate higher nutritional value of cookies with added health benefit by addition of Buckwheat flour, Pearl millets, and maize flour and with whole wheat flour, which is extremely important as it takes an important place among the crops, which are a good source of protein, minerals and trace elements. Multigrain biscuits will formulate by blending refined wheat flour and multigrain flour (Wheat flour, Pearl millet, Maize and Buckwheat) in 60:40 ratio. Incorporation of multigrain flour enhancing the nutritive value of the sweet biscuits. The functional properties of different blends of composite flour were studied. Cookies were prepared by using different ratios of composite flour. Cookies, among the bakery products, are most significant in the world. These are an important food product used as snacks by children and adults. Cookies differ from other baked products like bread and cakes due to their low moisture content which ensures that they are free from microbial spoilage and confer a long shelf life on the product. For the study nutrismart village Sihoda was selected. To evaluate the impact and acceptability 6 to 8 years school going children were selected. Their per day consumption of multigrain biscuits and Anthropometry were taken and assessed. In the present study children were provided multigrain biscuits for three month. Before study children were taken only plain biscuits made from refined wheat flour. Multigrain biscuit was found to have higher phenol compounds, flavonoids and mineral content (K, Mg, Zn, and Cu) than wheat flour. The height and weight showed significant changes in selected subjects. The calories, protein, calcium and iron value of multigrain biscuits was found to be 260kcal, 6.8 gm, 40.05mg and 3.46 mg respectively.

Keywords: Buckwheat, pearl wheat, maize, multigrain biscuits, cookies, anthropometry measurements

Introduction

Bakery products have become popular among different cross sections of the consumers are demanding in these days, foods that show two main properties; the first –one deal with the traditional nutritional aspects of the food, as well as, a second feature, additional health benefits are expected from its regular ingestion. Population due to an increased demand for convenience foods. The penetration of biscuits in urban and rural market is 85% and 55% respectively (Divya, 2011) [10]. These are an important food product used as snacks by children and adults. Consumers are demanding in these days, foods that show two main properties: the first-one deals with the traditional nutritional aspects of the food, as well as, a second feature, additional health benefits are expected from its regular ingestion. The development of new products is a new strategic area of the food industry. In this study, we attempted to access the suitability of replacement of “Maida” by using other flours. Nutritional enrichment is of current interest because of consumer trends, government guidelines and changing demographics. These factors are causing the industry to be aware of the need for nutritional food products. Protein supplementation is one way to meet the need for nutritious foods, particularly baked products. The nutritional significance of the bakery products is well recognized. Attempts are being made to enrich the products with high-quality non-wheat flours. Bakery products can serve as a good vehicle for carrying the added proteins to target populations for use in combating the protein malnutrition prevalent in many parts of the world. The bakery industry in India produces bread, biscuits, cakes, buns in lake of tones annually in which the share of biscuits is highest. Biscuits, cookies industries are generally facing a problem of nutritional value as cookies are low.

The term cookies are Dutch word koekje and its means a little cake and the name biscuits is the Latin word which mean big coctum (Macre *et al.*, 1993). It is a bakery product and usually consumed by all age group mostly school going children (Shahzad *et al.*, 2006). Cookies are prepared by supplementing different low priced sources like pulses and legumes flour with wheat flour (Akubor and Onimawo, 2003)^[8].

In 19th century British took a liking to them by incorporating into their daily tea services and calling them biscuits or sweet buns, as they do in Scotland (Blessy *et al.*, 2017)^[9].

The health care costs for this growing age group will likewise increase, especially for curative care, even though prevention is recognized as more economical and sustainable (Chernoff, 2006)^[9]. Cookies differ from other baked products like bread and cakes because of their low moisture content which ensures that they are free from microbial spoilage and confer a long shelf life on the product (Wade, 1988). Cookie is a small, flat, sweet, baked food, usually containing flour, eggs, chocolate, sugar and either butter or cooking vegetable oil. It may also include other ingredients such as raisins, oats, dry fruit or nut. Nutritional enrichment is of current interest because of consumer trends, government guidelines and changing demographics. These factors are causing the industry to be aware of the need for nutritional food products. Protein supplementation is one way to meet the need for nutritious foods, particularly baked products. The nutritional significance of the bakery products is well recognized. Attempts are being made to enrich the products with high-quality non-wheat flours. Bakery products can serve as a good vehicle for carrying the added proteins to target populations for use in combating the protein malnutrition prevalent in many parts of the world.

An approach was made in the present study, to replace the wheat flour in cookies by multigrain flour in order to increase the protein, fibre and other nutrients. Keeping the above views, the present investigation has been developed to prepare nutrient rich cookies.

Wheat is the most common cereal available all over the world and is in even higher demand in recent years due to its abundant health benefits. Oats are rich source of dietary fiber but more importantly, oats are high in fiber, specifically, β -glucan, which reduces blood cholesterol level by increasing the excretion of bile in the body (Jenkins and Kendall, 2002). Oats can be considered a high calorie food containing 19 per cent more calories than wheat. Wheat is an immense energy source through all parts of the grain kernel, including the bran, germ, and endosperm. Wheat is the principal cereal widely used for making bread than any other cereal. The protein called gluten makes bread dough stick together and gives it the ability to retain gas (Narayana *et al.*, 1982). Wheat supplies about 20 percent of the food calories for the world's people and is a national staple in many countries. Wheat is the major ingredient in most breads, rolls, crackers, cookies, biscuits, cakes, doughnuts, macaroni, spaghetti, puddings, pizza, and many prepared hot and cold breakfast foods. Wheat is rich in catalytic elements, mineral salts, calcium, magnesium, potassium, sulfur, chlorine, arsenic, silicon, manganese, zinc, iodide, copper, vitamin B, and vitamin E.

Buckwheat belongs to a group of foods commonly called pseudo cereals. Pseudo cereals are seeds that are consumed as cereal grains but don't grow on grasses. Other common pseudo cereals include quinoa and amaranth. Despite its name, buckwheat is not related to wheat and is thus gluten-

free. It's used in buckwheat tea or processed into groats, flour, and noodles. The groats, used in much the same way as rice, are the main ingredient in many traditional European and Asian dishes. Buckwheat mainly consists of carbs, which make up about 20% of boiled groats by weight. They come in the form of starch, which is carbs' primary storage form in plants. Buckwheat scores low to medium on the glycemic index (GI) - a measure of how quickly a food raises blood sugar after a meal and should not cause unhealthy spikes in blood sugar levels. Some of the soluble carbs in buckwheat, such as fagopyritol and D-chiro-inositol, have been shown to help moderate the rise in blood sugar after meals. Buckwheat contains small amounts of protein. By weight, protein composes 3.4% of boiled buckwheat groats. Because of its well-balanced amino acid profile, the protein in buckwheat is very high quality. It is particularly rich in the amino acids lysine and arginine. Common buckwheat mostly consumed as compared to other species because it is sweet in taste and easy to dehul as compared to tartary buckwheat because it has bitter taste, small in seed size and tough seed coat for that reason it is hard to dehul (Jiang *et al.*, 2007)^[13]. Buckwheat grown throughout the world there are different species of buckwheat mostly two types of buckwheat (Common buckwheat and Tartary buckwheat) used as a source of food throughout the world and other nine of them only has nutritional and agricultural value (Krkoskova and Mrazova, 2005).

Bajra is a traditional Hindi name for the *Pennisetum glaucum* crop, also known as pearl millet. It's likewise known as Dukn, Cumbu, Gero, Sanio, Kambu, Babala, or bulrush millet. The grain is primarily grown in Africa and India, where it's a major source of nutrition. However, it's also grown and consumed in many other places around the world. Bajra refers to the edible seeds of pearl millet plants. They grow in various shades of white, yellow, gray, brown, and Bajra is high in beneficial plant chemicals like antioxidants, polyphenols, and phytochemicals, all of which are known for contributing to optimal human health in many ways. However, the presence of beneficial polyphenols may also inhibit some of the minerals in bajra, such as iron and zinc, from being fully absorbed by your body. The seeds are typically cooked as a cereal grain or sometimes finely ground and used as a flour. Cooked millet is a good source of protein and carbs and a decent source of fiber. It's also a good source of vitamins and minerals. Overall, millet is a nutritious carbohydrate source. It's also gluten-free and a suitable choice for people with celiac disease or those following a gluten-free diet as long as you ensure that you're purchasing a product that's certified gluten-free. Bajra is commonly ground into a fine flour that can be used to make roti and other types of flatbread. Bajra has good potential of providing nutritional security to the consumers (Kanchana *et al.* 2017).

Maize is enriched with thiamine, riboflavin, niacin, pantothenic and folic acid as well. Maize is a rich source of carotenoids such as beta-carotene, zeaxanthin, lutein and cryptoxanthin which have highly diverse health benefits ranging from maintaining normal vision to lowering of oxidative stress. Maize is also rich in phosphorus, magnesium, zinc, copper, iron and selenium, and has small amount of potassium and calcium. Maize is a good source of dietary fiber and protein, while being very low in sodium (salt) and fat. Cookies are considered better for supplemented/composite flours due to their ready-to-eat form,

wide consumption, relatively long shelf-life and good eating quality (Tsen *et al.*, 1973). Cookies with high sensoric attributes have been produced from blends of millet/pigeon pea flour (Eneche, 1999), raw rice and wheat (Singh *et al.*, 1989), black gram and wheat (Singh *et al.*, 1993), chickpea and wheat (Singh *et al.*, 1991), wheat and cowpea (McWatters *et al.*, 2003). Nutritional and functional properties of banana peel powder could be well suited for baked products like cookies, muffins, bread, crackers, pastries, and pancakes.

Due to changing lifestyle, the people have started demanding ready to cook or ready to serve convenience foods. Among ready-to-eat snacks, biscuits possess several attractive features including wider consumption base, relatively longer shelf-life, more convenience and good eating quality (Hooda and Jood, 2005). Long shelf life of biscuits makes large scale production and distribution possible. The multigrain blends helps to mix different whole grains to maximize their nutritional, functional and sensory properties. Keeping in view, the tremendous benefits of the selected underutilized crops, i.e. buckwheat and barley, the present study was undertaken to assess the nutritional, nutraceutical and sensory attributes of the developed product.

The above work was focused on the following objectives

1. Development of functional multigrain cookies.
2. To study the Nutritive values of prepared cookies samples.
3. To study the effect of cookies on Anthropometric measurements of selected children in Nutrismart village sihoda in Jabalpur district.

Materials and Methods

Selection of samples

For the study Nutrismart village sihoda, block Shahpura, Jabalpur was selected. The study was under taken from the year 2020 to 2022 for the three years under the front line demonstration in Krishi Vigyan Kendra Jabalpur (M.P.).

Screening of children

For the study total 30 children of the age of 6 to 8 years were selected. These children were selected from the purposive random sampling method. All mandatory details of children were collected from the school records, where these children were studying. The date of birth and the age of subjects were confirmed from the school records.

For the study 50 gram multigrain biscuits were provided for three months. After the study their anthropometry measurements were taken and changes were noted. The nutritive values of multigrain biscuits were calculated.

Preparation of Multigrain Biscuits

All the ingredients such as buckwheat flour, pearl millets and maize, butter or oil, baking powder/baking soda and skim milk were collected from the local market. Multigrain biscuits will formulate by blending refined wheat flour and multigrain flour (maize, oat, pearl millet) in 60:40 ratio. Multigrain biscuits were prepared from wheat flour, buckwheat flour, pearl millets flour and maize flour [60:10:10:10]. Other ingredients were sugar (40%), fat (40%), baking powder (0.5%) and water. Method of preparation of Multigrain biscuits showed in following flow charts-

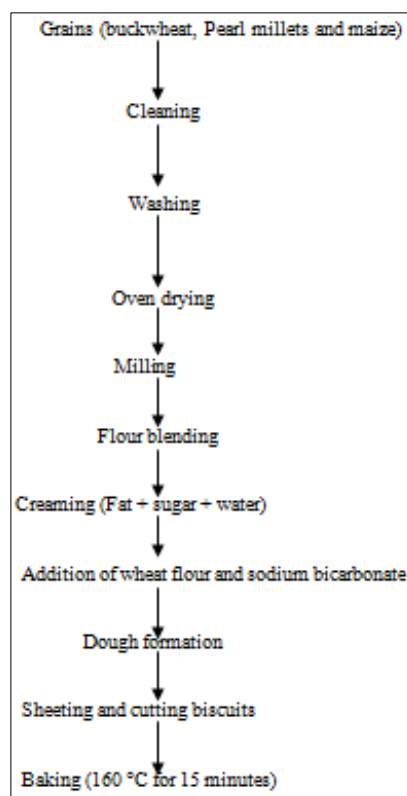


Fig 1: Flow chart for preparation of multigrain biscuits

Supplementation of multigrain biscuit: Selected children were provided 50 gram multigrain biscuits for three months. These biscuits were given for three months.

Assessment of nutritive value: For calculation of nutritive value of multigrain biscuits, its converted into raw food stuff with the help of standard recopies (Gopalan *et al.*, 2012). Nutritive value of raw ingredients of the cooked food consumed were calculated using the food composition table (ICMR 2017)), giving due provision for the processing losses.

Assessment of anthropometric measurements: After supplementation anthropometric measurements of the children were done. Their height and weight was measured.

Results and discussion – Nutritional contents

Calories: Diet in early childhood plays an important role in development and growth (Walker SP *et al.*, 2011). Calories content of the multigrain biscuits was found to be increased from 169 kcal to 260 kcal / 50 gram with the supplementation of refined wheat flour with composite flour of buckwheat, pearl millets and maize flour (table -1). This might be due to the higher energy content in maize, buckwheat and pearl millets flour. In children the calorie requirement is calculated based on the age, sex, and activity status of the child. Children during a growth spurt, require higher amount of calories to maintain the body as well as grow (Unaiza *et al.* 2021)

Table 1: Calories content (kcal/50gm) in both biscuits

Type of biscuits	Quantity gm	Calories (kcal)
Plain biscuits	50 gm	169 kcal
multigrain biscuits	50 gm	260 kcal

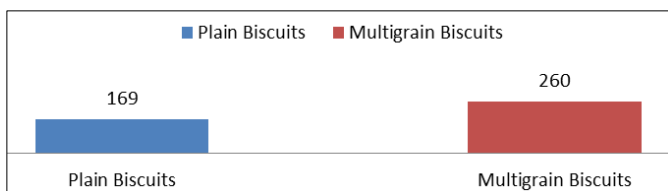


Fig 2: Calories (Kcal)

Protein: Protein content of the multigrain biscuits was found to be higher than the plain biscuits. It provided 6.8 gm protein while plain biscuits provided only 4.2 gm protein. Protein intake in childhood is important because it provided essential amino acids required for protein synthesis, which are necessary for growth (Michaelsen *et al*, 2014). When intake is too low, growth during childhood is restricted (Allen L.H. *et al*, 1994). When the calorie intake is less than the required amount, than the protein stops its primary function of body building and starts giving energy to the body. Thus growth and development of children is hampered. Due to amino acids supplementation the quality of protein quality should be superior. The dietary protein requirements of children are intended to be an estimate of the minimum continuous daily intake of "good quality" protein needed to prevent deficiency and ensure normal growth and development (Trumbo P. *et al*, 2002). Buckwheat contains small amounts of protein. By weight, protein composes 3.4% of boiled buckwheat groats. Because of its well-balanced amino acid profile, the protein in buckwheat is very high quality. It is particularly rich in the amino acids lysine and arginine. As compare to other cereal crops it has more protein and lysine content and gluten free that why it is more important medicinal and nutritional crop. Therefore, it used to prepare an alternate gluten free food for celiac patients (Javornik and Kret, 1984 and Eggum, 1980). They found that there was a well concentration of amino acids in buckwheat (Kato *et al.*, 2001). Among them needed amino acid like lysine, threonine and tryptophan are in high value (Liu *et al.* 2001).

Table 2: Protein content (gm/50gm) both biscuits

Type of biscuits	Quantity (gm)	Protein (gm)
Plain biscuits	50	4.2
multigrain biscuits	50	6.8

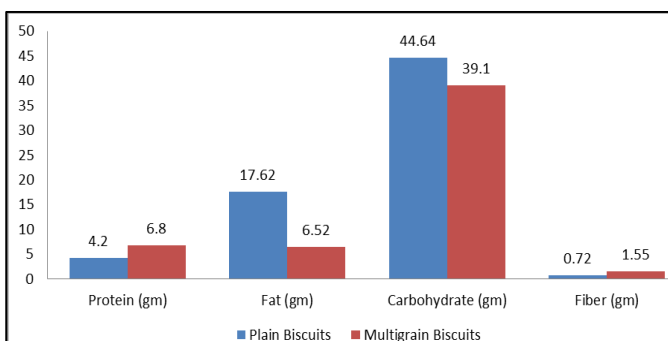


Fig 3: Show the plain and multigrain biscuits

Fat: Fat content of the multigrain biscuits was found to be higher than the plain biscuits. It provided 17.62 gm fat, while plain biscuits provided only 6.52 gm fat. This might be due to the better content in maize, buckwheat and pearl millets flour. A clinical deficiency of essential fatty acids results in neurological abnormalities and poor growth (Institute of

medical 2005). There is emerging evidence that omega -3 fatty acid intake in early childhood (Ohlund *et al.*2008).

Table 3: Fat content (gm/50gm) in both biscuits

Type of biscuits	Quantity (gm)	Fat (gm)
Plain biscuits	50	17.62
multigrain biscuits	50	6.52

Carbohydrate: Fat content of the multigrain biscuits was found to be slightly higher than the plain biscuits. It provided 44.64gm, while plain biscuits provided only 39.1gm carbohydrate. carbohydrates are broken down by the body into simple sugars. These sugars circulate in the bloodstream and are used by the body's cell for energy. The brain also uses one of these simple sugars (glucose) as its primary energy source. These is why children need carbohydrates to stay alert and active throughout the day.

Table 4: Carbohydrate content (gm/50gm) in both biscuits

Type of biscuits	Quantity (gm)	Carbohydrate (gm)
Plain biscuits	50	17.62
multigrain biscuits	50	6.52

Calcium: Calcium content of the multigrain biscuits was found to be increased from 40.5 mg to 9.2 mg /50 gm with the supplementation of refined wheat flour with composite flour of buckwheat, pearl millets and maize (Table-3). This might be due to the higher calcium content in buckwheat and pearl millets. Yildiz and Bilgili (2012) reported increase in calcium content of bread *Lavas* with the blending of whole buckwheat flour. Buckwheat is an excellent source of micronutrients (Ikeda and Yamasitha 1994). Buckwheat is naturally gluten free and contains various kinds of essential nutrients including easily digestible protein, starch, essential minerals (Zn, Fe, K, Ca, Mg, Mn, and Cu), amino acids (lysine) and rutin (Bonafaccia *et al.*).

Table 5: Calcium content (mg/50gm) in both biscuits"

Type of biscuits	Quantity (gm)	Calcium (mg)
Plain biscuits	50	9.2
multigrain biscuits	50	40.5

Iron: There was a significant increase in iron content of multigrain biscuits upon the incorporation of Pearl millets, Maize and buckwheat composite flour which was noted to be ranged from 2.10 to 4.00 mg/50g (Table 6). Higher iron content of the composite flour might be the reason behind increasing trend in iron content of the blended biscuits. Arshad *et al.* (2014) reported increase in iron content with the incorporation of barley and oat flours in wheat flour while making multigrain cookies.

Table 6: Iron content (mg/50 gm) in both biscuits

Type of biscuits	Quantity (gm)	Iron (mg)
Plain biscuits	50	2.10
multigrain biscuits	50	4.00

Zinc: Zinc content of multigrain biscuits significantly increased from 1.30 to 2.50 mg/50g with the increase in the levels of composite flour in the wheat flour which might be due to higher zinc content of the buckwheat, maize and pearl millets (Table 3). Hooda and Jood (2005) observed similar trend in fenugreek supplemented biscuits.

Table 7: Zinc content (mg/50 gm) in both biscuits

Type of biscuits	Quantity (gm)	Zinc (mg)
Plain biscuits	50	1.30
multigrain biscuits	50	2.50

Changes in anthropometric parameters before and after biscuits supplementation

Table 7 gives details regarding the mean increments in height and weight of the children. After three months of supplementation of multigrain biscuits, anthropometric measurements of the subjects were taken. In these measurements height and weight of subjects were measured. In the present study, it was observed that after three months of supplementation height and weight was increased significantly. Owino *et al.* (2007) [2] have reported that supplementation of energy dense foods have improved the biochemical values. Mean weight of supplemented children increased by the end of study period compared to the baseline value. In another study supplementation of fortified products for six months has significantly improved the anthropometric measurements (Shivakumar B *et al.* 2006). Table 7 indicated that mean values of children's weight was significantly increased by 350 gm. This may be due to the fortification of micronutrients dense foods in the multigrain biscuits supporting these findings, supplementation of fortified fruit powder beverage for 16 weeks showed significant improvements in cognitive performance. The mean height increment of the selected subjects was found 0.80 cm.

Similar findings have been reported in various research studies (Hyder SM 2000) [4]. In another study supplementation of beta-carotene fortified biscuits significantly improved the cognitive functions of the children [Van Stuijvenberg ME 1999] [5].

**Fig 4:** Multigrain Biscuit**Fig 5:** Distribution of Multigrain**Fig 6:** Biscuits in Nutrismart village Sihoda

Conclusion

The present study concluded that Pearl millets, maize and buckwheat flour contain good source of energy, starch, protein, fibre and other essential nutrients which could be of benefits to human. This study suggest that these flours could be utilized as partial replacement in common cereal for development of cookies and other bakery products, as source of energy and can also contribute to the improvements of nutritional status of prepared cookies

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