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Research Article

NUTRIENT COMPOSITION OF AMARANTH FLOUR INCORPORATED READY MIX

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A B S T R A C T

In Indian diet, amaranth grain is easily incorporated in the traditional cuisine and provides a high protein, high fibre alternative to wheat. In combination with other grains, amaranth is processed to make cold and hot breakfast cereals, bread, crackers and pancakes (Dixit. *et al*, 2011). This study involves determination of nutrients in amaranth flour incorporated to different cereal flours (Red rice and Wheat) at 15, 30 and 60 percent levels. The ready mix could be used in the preparation of breakfast items like puttu, idiyapam and adai.The raw materials were subjected to pre-treatment, formulated as ready mix and subjected to nutrient analysis.The research findings concluded that the combined use of wheat flour and amaranth flour, Red rice flour and amaranth flour in developing instant mix such as Puttu/kozhukattai, Adai and Idiyappam at different studied levels resulted with greater protein, energy, fat, fiber, iron and calcium content than simply prepared ready mix with wheat and red rice flour. The best quality attributes were observed in the ready mix made from 60 percent amaranth flour incorporation. Thus partial substitution of wheat and red rice flour by amaranth flour improve the nutritional quality of the ready mix products.In this regard, production of value-added food product from under-utilized raw material is the way to reward the valuable nutrients to the society by changing the amaranth into value added food products.

INTRODUCTION

Background

Before any nutritional research was carried out, the value of grain amaranth was recognized by people from Mexico to Peru to Nepal. Grain amaranth was traditionally used during fasting period and for people recovering from an illness. In India amaranth is known as 'rajgeera' and is often popped to be used in confections called as "laddoos". In Nepal, amaranth seeds are milled in to flour to make chappatis (flat pan bread) and seeds eaten as such or as a gruel called 'sattoo' (Rosa.*et al*, 2009).

A critical amino acid lysine is found to be in higher proportion in amaranth grain, ranging from 0.73 to 0.84 percent of the total protein content. Amaranth is not a cereal grain but a pseudo-cereal from dicotyledonous plant and is used by people who are allergic to other cereal grain. In combination with other grains, amaranth is processed to make cold and hot breakfast cereals, bread, crackers and pancakes. Popped amaranth provides a good opportunity to develop innovative products for the processors.

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In Indian diet, amaranth grain is easily incorporated in the traditional cuisine and provides a high protein, high fibre alternative to wheat (Dixit. *et al*, 2011).

MATERIALS AND METHODS

This study involves the determination of nutrients in amaranth flour incorporated to different cereal flours (Red rice and Wheat) at 15, 30 and 60 percent levels. The ready mix could be used in the preparation of breakfast items like puttu, idiyapam and adai. The Raw materials (Red Rice, Wheat, Amaranth Seeds and Pulses) were procured from organic stores in Anna Nagar, Chennai.

Pre Treatment

Pre treatment involves cereal grinding (Red rice, Wheat and Amaranth) inEntury flour mills limited, using a table top hammer mill and passing it through 100 mesh sieve. The flour was collected and shade dried with a mesh covering the flour for 10 minutes and it was stored in zip lock bags and kept in airtight Tupperware box at ambient condition. Each of the flour (Red Rice, Wheat and Amaranth) was separately packed in a previously washed and dried clean muslin cloth and it was subjected to heat treatment by steaming in a cooker for 15 minutes.

Formulation of ready Mix products by incorporating amaranth flour at various levels (15 per cent, 30 per cent, and 60 per cent)

In our study five ready mix flours were formulated as detailed below.

- Amaranth flour incorporated red rice puttu (Red rice steamed flour) at 15, 30 and 60 percent level.
- Amaranth flour incorporated red rice idiyapam (Red rice extruded product) at 15, 30 and 60 percent level.
- Amaranth flour incorporated wheat puttu (Wheat steamed product) at 15, 30 and 60 percent level.
- Amaranth flour incorporated wheat idiyapam (Wheat extruded product) at 15, 30 and 60 percent level.
- To Amaranth flour incorporated red rice adaiat (Red rice pancake flour) 15, 30 and 60 percent level.

The standardizationand formulation of ready mix were prepared usingweighing measure of ingredients using weighing scale in the foods laboratory in the Department of Clinical Nutrition and Dietetics, Ethiraj College for Women, Chennai by the investigator. Ingredients were takensuch that the final quantity of each uncooked product was hundred grams. The red rice/wheat and amaranth ratio in control, 15, 30 and 60 percent instant red rice/wheatputtu were 100:0, 85:15, 70:30 and 40:60. The red rice/wheat and amaranth ratio in control, 15, 30 and 60 percent instant red rice/wheatidiyapam were 100:0, 85:15, 70:30 and 40:60. The red rice and amaranth ratio in control, 15, 30 and 60 percent instant red rice adai were 100:0, 85:15, 70:30 and 40:60.

250 grams of raw sample of amaranth (Amaranth Caudatus) seeds were weighed and used for nutrient analysis. Five kilogram of each of the prepared ready mix was divided into twenty five portions and packed in polythene Zipper bags and stored in airtight container at room temperature. One packet was used for nutrient analysis. The other packets were used for further studies on storage stability and preparation of breakfast items. The analysis was done at Chennai Labs Private Limited, Guindy, Chennai, Tamil Nadu, India which is a NABL accredited lab. The raw sample of amaranth Seed and the ready mixes were analysed for their composition by standard procedures. The nutritive value of amaranth seeds were tabulated below:

Parameters	Values	Units	Methods
Energy	378	Kcal/100 g	FAO Method
Carbohydrate	69.0	g/100 g	CTL/SOP/FOOD/262 - 2014
Total Fat	5.53	g/100 g	AOAC 20th Edn.2016, 954.02
Protein	13.00	g/100 g	AOAC 20th Edn.2016, 986.25
Dietary Fiber	6.89	g/100 g	AOAC 20th Edn.2016, 985.29
Calcium	118.00	mg/100 g	IS 5949:1990 (RA.2003)
Iron	3.62	mg/100 g	AOAC 20th Edn.2016, 999.11
Moisture	10.10	g/100 g	IS 1155 : 1968 (RA.2005)

Nutrient Analysis

All the ready mix samples were analysed for their nutrient composition. Estimationof moisture (g %) by IS 1155: 1968 (RA.2005). The method involved drying under infrared radiation, in equipment (IR-35 Infrared Moisture Analyzer) composed of electronic precision balance. Energy (Kcal/100g) was done by the FAO Method (Calculation by difference), carbohydrate (g %) by Anthrone method (Hodge *et al.,* 1962; CTL/SOP/FOOD/262 – 2014), protein (g %) by the Kjeldahl method (AOAC, 986.25)(N x 5.6). The total fat content (g %) was determined using solvent extraction method. The total fat content was determined using Soxhlet extractor using petroleum-ether solvent by the AOAC 954.02 protocol was used. Total dietary fibre (g%) content was measured according to the AOAC (985.29) enzymatic-gravimetric method. The basis of this method is the isolation of dietary fibre by enzymatic digestion of the rest of the constituents of the material. The residue was measured gravimetrically.

Ashing is the first step in preparing a food sample for specific elemental analysis. The samples of food commodities were subjected to incinerationin a muffle furnace at 550°C for 5-6 hours to obtain the ash for the determination of mineral content. Then, the residue is dissolved in 20 mL of 6 mol L^{-1} hydrochloric acid and diluted to 100 mL with deionized water. Iron (mg / 100g) was determined spectrophotometrically by AOAC, 999.11, and calcium (mg / 100g) titrimetrically by IS 5949:1990 (RA.2003). All estimations were done in triplicates. The results obtained were evaluated using basic statistical characteristics, Mean, Standard deviation and paired 't' Test. SPSS 20.0 was used for the statistical analysis.

RESULTS AND DISCUSSION

The present study involves the determination of nutrients in amaranth-cereal flour (Red rice and Wheat) ready mix incorporated to different cereal flours at different stages of 15, 30 and 60 percent levels for the recipes like puttu, idiyapam and adai. The observations and discussions of the present study are presented and discussed below:

Table 1 Nutrient Composition of Amaranth incorporated instant puttu/kozhukattai mix

Nutrients	Wheat-Amaranth flour				Rice-Amaranth flour			
	Control	15%	30%	60%	Control	15%	30%	60%
Moisture (%)	12.2	11.885	11.57	10.94	12.6	12.2	11.9	11.1
Energy (Kcal)	341	347	352	363	349	354	357	365
Carbohydrates(g)	69.4	69.34	69.28	69.16	77	76	74	72
Protein (g)	12.1	12.235	12.37	12.64	8.50	9.175	9.85	11.2
Total fat (g)	1.7	2.2745	2.849	3.998	0.60	1.3395	2.079	3.558
Dietary fibre (g%)	1.9	2.6485	3.397	4.894	0.00	1.0335	2.067	4.134
Calcium (mg)	48	58.5	69	90	10.00	26.2	42.4	74.8
Iron (mg)	4.9	4.708	4.516	4.132	2.80	2.923	3.046	3.292

Table 1 describes the variation in nutrients in amaranth flour incorporated wheat flour and red rice flour instant puttu/Kuzhukattai mix at different stages of control, 15, 30 and 60 percent level.Macronutrients such as energy (363, 365 Kcal), protein (12.64,11.2 gm) and fat (3.998,3.558 gm) valueswere found to be in high in 60 percent amaranth flour incorporated mix both in wheat and red rice flour instant mix comparedto other compositions. Also dietary fiber (4.894, 4.134 gm) and calcium (90,74.8 mg) leads in 60 percentamaranth incorporation in both the mix. Moisture content (12.2,12.6 %) and carbohydrate (69.4, 77 gm) is dominated in control food mix which is prepared without amaranth flour in both the flour mix. Iron content is found high in wheat flour control (4.9 mg) whereas in red rice mix, 60 percent amaranth incorporation results in high level (3.292 mg).

In Asia, the Indian traditional cuisine started incorporating amaranth grain in place of wheat for their high protein and high fiber content. In many clinical studies, properties of amaranth in reducing cholesterol, as an anti-oxidant, anticancer, anti-allergic, anti-hypertensive agent and diet in

patient with celiac disease and immuno-deficiencies have been studied (Dixit *et al*, 2011).

Nutritionally, amaranth grains have higher protein content (13.56gm), higher digestibility, higher protein utilization, and a higher protein efficiency ratio than traditional cereals such as corn and wheat. Poor population often lack high quality protein and micronutrients, amaranth grain makes a solution for this condition by fighting malnutrition and nutritional deficiencies for such group (Muyonga.*et al*., 2008).

Table 2 Nutrient Composition of Amaranth incorporated of Instant idiyappam mix

Nutrients	Wheat-Amaranth flour				Rice-Amaranth flour			
	Control	15%	30%	60%	Control	15%	30%	60%
Moisture (%)	9.4	9.25	9.14	8.74	11.2	11.05	10.85	10.26
Energy (Kcal)	339.12	347.54	354.65	364.65	347	351.75	355.53	362.81
Carbohydrates(g)	68.41	69.78	70.04	70.41	77.1	75.8	73.98	72.15
Protein (g)	12.34	12.62	12.94	13.16	8.32	9.087	9.765	10.98
Total fat (g)	1.3	1.95	2.345	4.054	0.6	1.32	2.11	3.54
Dietary fibre (g%)	1.52	2.12	2.97	4.18	0	1.15	1.87	3.76
Calcium (mg)	54.2	61.74	73.28	94.72	7	19.27	37.84	68.92
Iron (mg)	5.12	4.85	4.37	4.05	2.4	2.8	3.1	3.2

Table 2 depicts the nutritional value of amaranth flour incorporated wheat flour and red rice flour instant idiyappam mix at different stages of control, 15, 30 and 60 percent level. The instant wheat and red rice idiyappam mix with 60 percent amaranth flour shows increased energy (364.65,362.81 Kcal), total fat (4.054,3.54gm), protein (13.16,10.98gm), dietary fiber (4.18,3.76gm) and calcium (94.72,68.92mg) compared to other variations. Values of Iron (5.12mg) in wheat flour idiyappam mix is high in control than the other composite flours whereas in red rice mix the iron range is high in 60 percent amaranth flour composition. Carbohydrate in wheat mix is high among 60 percent composition (70.41gm) and in red rice mix (77.1gm) control provides highervalue. Moisture content of wheat flour (9.4 %) and red rice flour control (11.2 %) is high in control food mix which is prepared without amaranth flour.

The substitution of wheat flour with amaranth, one can contribute to improvement of food security and production of various gluten-free value added products (Emire and Arega, 2012). Leaves of amaranth are rich source of calcium and are known to strengthen bones and prevent osteoporosis. Calcium is necessary for active life to prevent demineralization especially during old age (Pasko *et al*, 2008). Amaranth leaf calcium content is said to meet the nutritional needs of calcium in a pregnant women (1500mg to 2000mg per day) (WHO, 2013).

Lysine in amaranth helps the body to absorb calcium, produce energy and muscle building. Inorder to increase the bioavailability of processed foods, a blend of amaranth with high lysine content is essential to make the food source attractive. Amaranth when mixed with other cereal grain flour the protein value is highlighted (Alvarez-Jubete.*et al*, 2010).
Table 3 compares the nutrients in red rice flour and amaranth flour incorporated instant adai mix at different stages of control, 15, 30 and 60 percent level.Energy (333.53Kcal), fat (3.31gm), protein (15.24gm), fiber (4.77gm), calcium (64.1mg) and iron (3.34mg) is found in higher range in 60 percent amaranth flour incorporated instant adai mix. Carbohydrate (63.23gm) and moisture (11.23%) content is high in control mix without amaranth flour.

Table 3 Nutrient Composition of Amaranth incorporated Instantadai mix

Nutrients	Rice-Amaranth flour			
	Control	15%	30%	60%
Moisture (%)	11.23	11.04	10.85	10.48
Energy (Kcal)	324.83	327.00	329.18	333.53
Carbohydrates(g)	63.23	62.60	61.97	60.71
Protein (g)	13.89	14.23	14.57	15.24
Total fat (g)	1.83	2.20	2.57	3.31
Dietary fibre (g%)	2.70	3.22	3.74	4.77
Calcium (mg)	31.70	39.80	47.90	64.10
Iron (mg)	3.10	3.16	3.22	3.34

The protein found in most of the grain is compared with amaranth grain; high amount of lysine, methionine and cysteine found in amaranth grain makes it an excellent source of high quality and balanced, complete protein. In addition they are also low in sodium and have no saturated fat. Amaranth is used in bakery products, gluten free foods, breakfast food and extruded foods. These grains are mixed with wheat flour for making leavened food (Elizabeth, 2010)
According to the investigation made in Purdue University, amaranth has high proportion of insoluble fiber (78 percent) and soluble fiber (22 percent) which is at higher range compared to wheat and maize (Delgado.*et al*, 2011). Consumption of around 50 – 100 grams of amaranth leaves everyday reduces the incidence of blindness in children as a result of poor or lack of nutritious diet. Crude protein content in amaranth leaves ranges from 20 – 32 percent (Yarger, 2008).

CONCLUSION

Due to its high nutritional value and interesting functional properties pseudocereals present an interesting alternative in order to increase the range of used plants for nutrition. Increased efforts are necessary to make these plants more known among the population. Until now, it is still only a low percentage of the population that knows or consumes these plants, in particular amaranth and quinoa. These aspects have to be considered primarily, if pseudocereals shall be marketed successfully in general and in large supermarkets in particular. Only this way the nutritional advantages of pseudocereals can be offered to a large portion of the population (Schoenlechner. *et al*, 2008). Owing to the scarcity of information on amaranth-containing composite flours and their rheological properties; the present study provides useful information on practical application for the formulation of value added products.

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