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Standardization of millets-based ready to eat nutritious food products for geriatrics

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Abstract
Geriatrics benefits from nutrient- dense convenience foods as they provide essential nutrients for aging bodies and simplifies meal preparation, ensuring easier access to well- balanced diets. Due to the changing lifestyle and migration of children outside for their jobs the increasing numbers of elderly are now a day's living alone or residing in elderly care facilities. They are not able to cook properly to feed themselves. Therefore, development of millets based nutrient- dense ready to eat food products will enable them to get sufficient nutrients. Keeping this in mind, the study on development of ready- to eat food products was carried out. Three products namely *Ragi* Oats Cookies (Snacks), Crispy *Sawan* Sticks (Savoury food), *Ragi Makhana* Booster Shake (Drink) were successfully standardized and its sensory acceptability and nutritional quality was assessed. The results of the study revealed that cookies containing *Ragi*: Oats 75:25 were rated best with a sensory score 8.62 which means were extremely liked by panel members. Crispy snacks prepared from *Sawan* (little millet) was prepared using different flavours like curry leaves, moringa leaves and mint leaves. The *Sawan* Sticks with mint leaves were extremely liked by panel members with mean sensory score 8.63. *Ragi Makhana* Booster (75:25) was rated best with overall acceptability score 8.5 means liked extremely on nine point hedonic rating scale.

Keywords: Geriatrics, nutrient-dense foods, millets, ready to eat food, sensory acceptability, nutritional quality

1. Introduction
'Geriatrics' is a French word derived from "Geras" (old age) and "Iatrike" (medicine), refers to the area of medicine that deals with the care and medical issues of the elderly (> 60 years old). According to (Kaur Damanpreet., 2019) [6], a country is considered to be aging when the population of elderly exceeds 7 percent of the total population. Ironically, the percentage of elderly in India has climbed to 10.1 percent in 2021 and is expected to rise even higher to 13.1 percent in 2031.

Nutrition plays a vital role as a determinant of well-being and quality of life of an individual (McNaughton, Crawford, Ball, & Salmon, 2012) [10]. Health and well-being of any individual depends on various factors like physical, social, psychological and nutritional (Raju, 2014) [11]. The process of aging is characterized by numerous changes in the body which has an overall negative effect on the health and life style of elderly (Hickson, 2006) [5]. Malnourishment in geriatric population results in physical dependence and pre mature deaths and it also impairs the immune system and increases the risk of infections and delayed wound healing (Wessels, 2021) [13].

The magnitude of malnutrition in elderly in India is underreported according to (Lahiri S, 2015) [8]. With advancement in age the energy requirements of elderly are reduced due to reduced body mass, body metabolism and physical activity etc. (Oshita, 2021). Yet older people are at high risk of under nutrition due to several reasons like lack of teeth, gum problems and ill-fitting dentures making eating painful, reduced appetite due to lack of exercise, loneliness, depression, chronic debilitating diseases, confusion, forgetfulness and due to lack of family support. Adequate dietary nutrition has an undisputed role in healthy aging (Kaur Damanpreet., 2019) [6].

Constipation is commonly seen in almost every older adult and daily consumption of 25 to 30 gram fibre proves beneficial in relieving constipation. Besides this, incorporation of good fats, particularly omega 3 fatty acids, low glycemic index foods, high biological protein sources and vitamin rich foods in the daily diet is associated with lowering cholesterol levels and thus helps to maintain a healthy lifestyle (Amarya, 2015) [3].

Elderly mostly depends on homemade foods to meet out their nutritional needs (Edfors, 2012.) [4]. In the changing world of elderly population either living alone in their homes or old ager homes has increased therefore the dependence of elderly to feed themselves has increased. Available food products in the market may not be suitable for elderly in terms of nutrients. To prevent elderly from becoming undernourished, balanced nutrient distribution in terms of macro and micro nutrients, low glycemic index, calorie density, adequate quality proteins etc. is needed. In addition, food for elderly should be easy to cook, easy to chew and easy to digest. It should be affordable and suit the choice of elderly. By combining foods from various food groups in right proportions, nutritious, acceptable and affordable products may be developed for promoting health and well-being of elderly (Parveen, 2022) [9].

Thus designing/developing special ready to eat and easy to cook foods rich in micronutrients, protein, low in sodium and rich in good quality fat containing omega 3 fatty acids needs to be done for maintaining proper health of elderly population. Therefore, the present study was undertaken to develop and assess the suitability of ready to eat and easy to cook healthy foods for senior citizens.

2. Materials and methods

Development of ready to eat food products

The standardization of healthy nutrient dense foods was done to help the elderly living in community dwellings either alone or with their families and those in old age homes. Three Ready to Eat convenience foods were developed. The raw material for product development was procured from the local market. The details of developed products illustrate in figure 1.

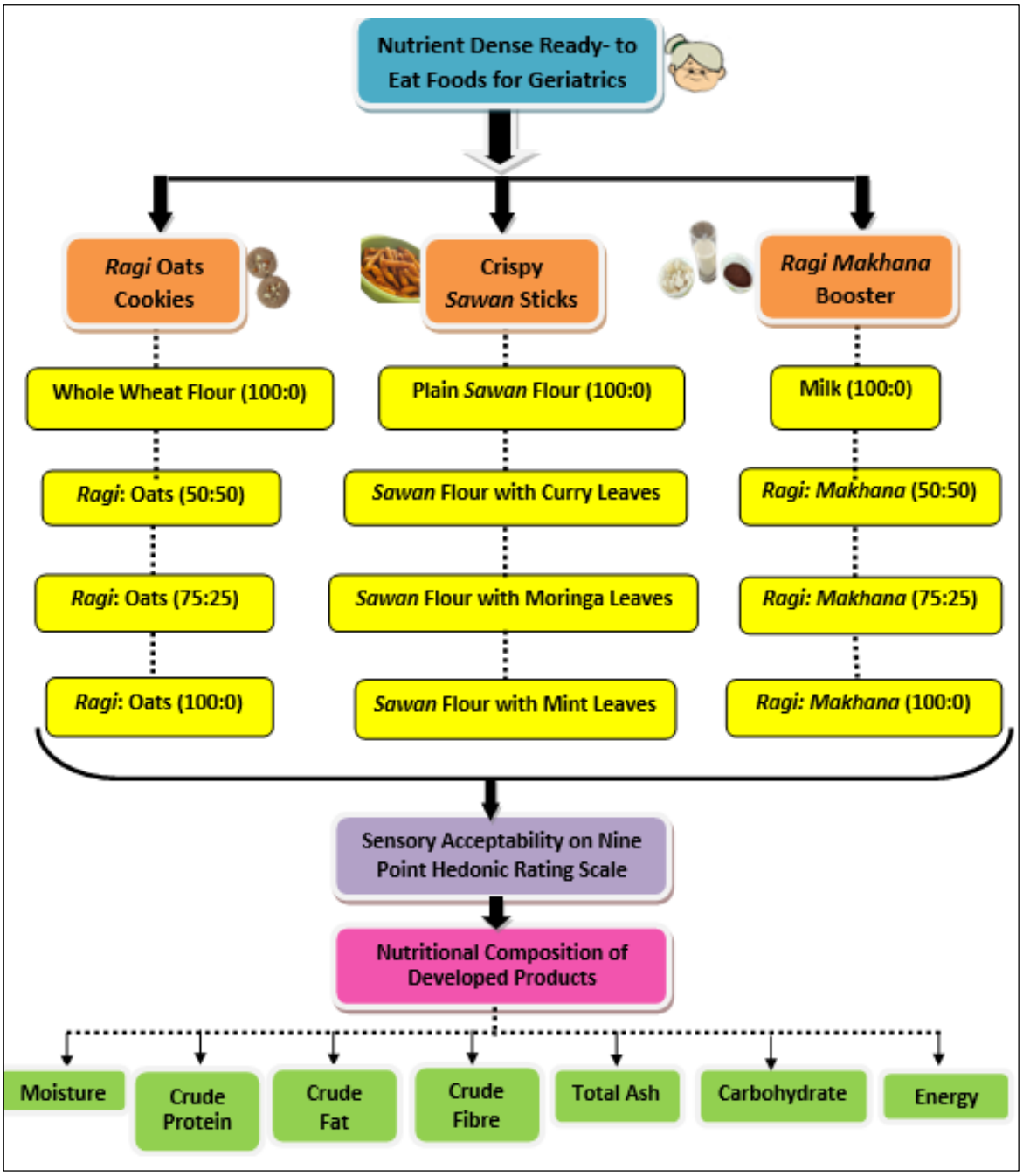

Fig 1: Development of Nutrient Dense ready to Eat Food Products for Geriatrics

2.1.1 Preparation of *Ragi* Oats Cookies (Roats Cookies)

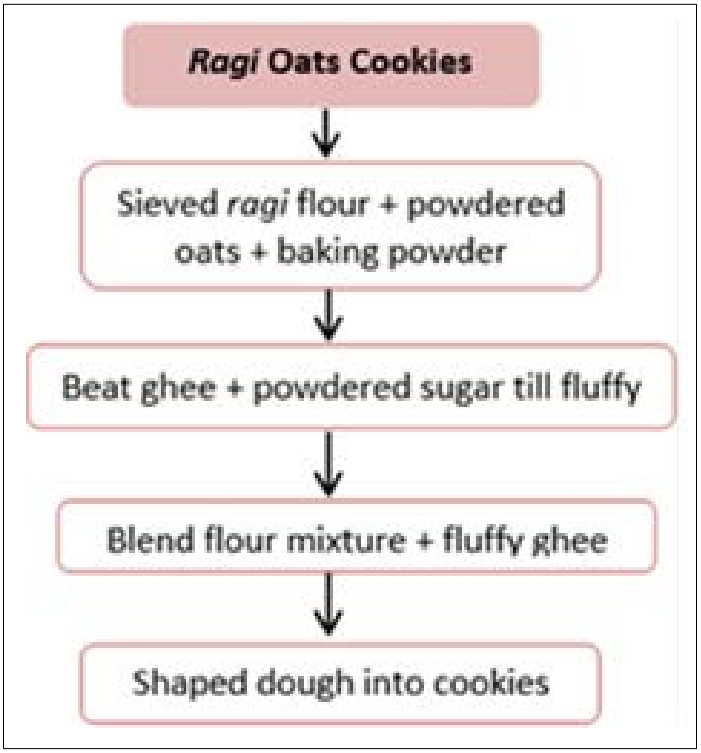

Fig 2: Shows development of Ragi Oats Cookies

2.1.2 Preparation of crispy sawan sticks

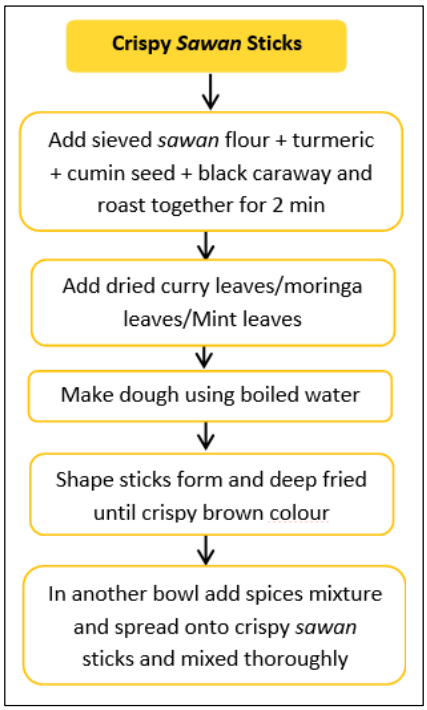

Fig 3: Shows development of Crispy *Sawan* Sticks

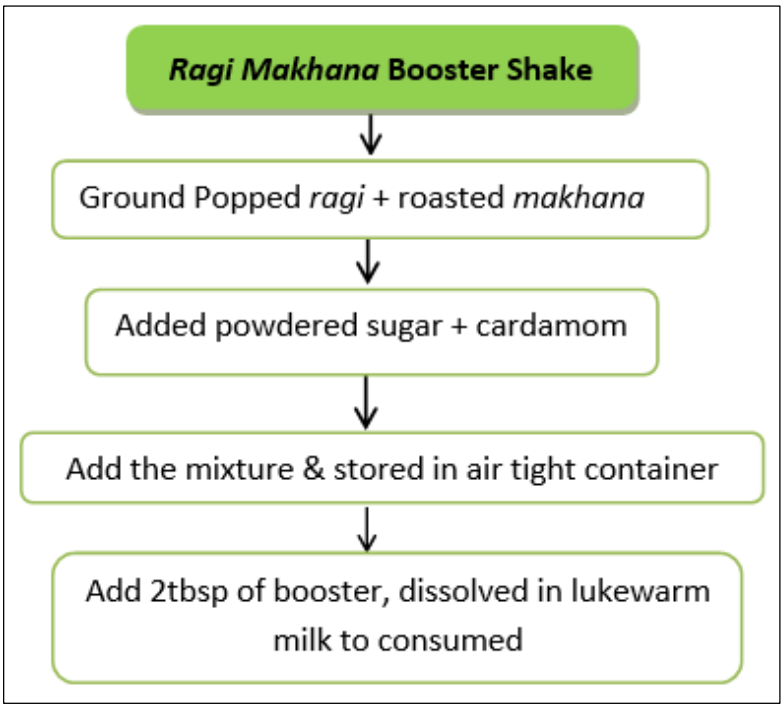

Fig 4: Shows development of Ragi Makhana Booster

2.1.3 Roats Cookies (*Ragi* Oats Cookies)

Ingredients

Table 1: Show Roats Cookies (Ragi Oats Cookies

Ragi flour (Finger millet) - 75 g	Powdered sugar - 50 g
Oats (powdered) - 25 g	Baking powder - ½ tsp
Ghee - 60 g	Vanilla essence - 1-2 drops

Method: Sieved *Ragi* flour and powdered oats. Added baking powder in it and sieved 3-4 times. In a separate bowl, beated *ghee* and added powdered sugar and continued beating till fluffy. Gradually added the flour mixture and blended well. Added vanilla essence and mixed. Shape the dough into cookies and placed them on a greased baking tray. Baked at 180 ºC for 15 to 20 minutes. Once golden and firm, cooled the

cookies on a wire rack.

Physical characteristics of cookies

Thickness: The thickness of cookies was determined by the placing of three stacking one above the other. The thickness was measured in centimeter using a scale. Cookies were rearranged and restacked thrice to get an average value for thickness and the results were reported in centimeters.

Width: The width of cookies was determined by placing of three edges to edge. The total width was measured in centimeter with the help of scale. To check the accuracy cookies were rotated at an angle of 90 ºC. This process is repeated thrice to get an average and the results were reported in centimeters.

Spread ratio: Spread value is calculated by dividing the average value of width by average value of thickness for cookies respectively.

The physical characteristics of *Ragi* Oats Cookies are presented in table 2.

Table 2: Physical characteristics of *Ragi* Oats Cookies parameters

Ragi: Oats Cookies	Width	Thickness	Spread Factor
Whole Wheat Cookies	24.1	5.3	4.6
Ragi: Oats (50:50)	23.3	5.1	4.6
Ragi: Oats (75:25)	24.3	5.1	4.8
Ragi: Oats (100:0)	23.8	5.1	4.7
C.D. 5%	0.270	N/A	-

3. Crispy *Sawan* Sticks

Ingredients

Table 3: Show Crispy Sawan Sticks

Sawan flour (Barnyard millet) – 200 g	*Chaat masala* - 2 g
Cumin seeds - 5g	Kashmiri *lalmirch* - 5 g
Turmeric powder - ½ tsp	Mangrail (Black caraway) - 1 tsp
Refined oil - 35 ml	Dry moringa leaves - 5g
Salt - to taste	Water - 1 cup
Black salt - 2-5g	

Method: Sieved *Sawan* flour. Added turmeric powder, cumin seeds and black caraway and roasted together for two minutes. Added Moringa leaves to the *Sawan* flour and dough was made using boiled water. Made small balls from this dough and shaped into sticks. Heated oil in a pan and fried sticks until they turned crispy and brown in color. In another bowl *chat masala*, Kashmiri *lalmirch* and black salt were added and mixed well. The spices mixture was spread onto the Crispy *Sawan* Sticks and mixed thoroughly. The prepared snack was stored in an airtight container and served with tea.

4. *Ragi Makhana* Booster

Ingredients

Popped *ragi* - 75 g
Roasted *makhana* - 25 g
Powdered sugar - 5 g
Cardamom powder - 1-2 Pinch

Method: Ground the popped *Ragi* and roasted *Makhana* in a mixer jar to a fine powder. Added cardamom powder and powdered sugar in it. Stored the booster in an airtight container. The *Ragi Makhana* booster is ready. Two tablespoon of this booster is dissolved in lukewarm milk and consumed.

Sensory Evaluation

Sensory evaluation of developed/standardized products was done by trained, semi-trained and untrained panel members i.e., elderly, faculty members, Ph.D. scholars and elderly using Nine Point Hedonic Rating Scale of dislike extremely to like extremely.

Cost Calculation: The cost of developed/standardized products was calculated based on the cost of raw materials used.

Nutritional Evaluation of Developed Products

The proximate analysis of the food products was done by the standard method of Association of Official Analytical Chemists (AOAC, 2000) [1]. Carbohydrate was calculated by difference method by subtracting the sum of the percentages of moisture, crude protein, crude fat, crude fiber and total ash from 100. The energy (Kcal) was determined by summing up the value obtained by multiplying the protein and carbohydrate value with 4 and fat with 9.

Fig 5: *Ragi* Oats Cookies with different proportion of *Ragi* and oats

Fig 6: Crispy Sawan Sticks with different flavours

Fig 7: *Ragi Makhana* Booster with different combinations of ragi and makhana

5. Results and Discussion

The mean sensory score of *Ragi*: Oats (Roats) cookies on a

nine point hedonic rating scale showed that cookies containing *Ragi*: Oats (75:25) were best scoring 8.62 i.e. liked extremely while *Ragi*: Oats (100:0) and *Ragi*: Oats (50:50) cookies scored 7.88, 7.69 i.e. liked very much. The Whole Wheat flour cookies scored 7.38. Thus it can be concluded that cookies can be prepared using *Ragi*: Oats into different proportions but the *Ragi*: Oats (75:25) is the best. This product contained 4.63 g crude protein, 12.41 g crude fat, 1.89 g crude fibre, 2.10 g total ash, and 76 g carbohydrate and 432 Kcal energy. The statistical analysis of data showed significant difference among different treatments with respect to crude protein, crude fat, crude fiber, total ash, and carbohydrate and energy contents. The protein content of wheat flour cookies was 4.58 g/100 g which increased to 4.60 g/100g in *Ragi*: Oats (50:50), 4.63g/100 g in *Ragi*: Oats (75:25) and 5.46 g/100g in *Ragi*: Oats (100:00) cookies. The sensory quality of *Ragi* Oats Cookies was determined and results are presented in table 2.

Table 2: Mean Sensory Score of *Ragi* Oats (Roats) Cookies on Nine Point Hedonic Rating Scale

Sensory Attributes/Treatments	Whole Wheat Cookies	*Ragi*: Oats (50:50)	*Ragi*: Oats (75:25)	*Ragi*: Oats (100:00)	CD (0.05)
Appearance	7.25	7.75	8.75	8.75	0.37
Color	7.25	7.75	8.00	7.75	0.43
Texture	7.50	7.50	8.75	8.00	0.34
Flavor	7.50	7.75	9.00	7.00	0.41
Overall Acceptability	7.38	7.69	8.62	7.88	0.53

Table 3: Proximate composition of *ragi* and oats cookies per 100 g

Treatments	Wheat Flour Cookies (100%)	Ragi: Oats (50:50)	Ragi: Oats (75:25)	Ragi: Oats (100:00)	CD (0.05)
Moisture (g)	5.2	6.32	5.35	5.41	0.31
Crude Protein (g)	4.58	4.6	4.63	5.46	0.31
Crude Fat (g)	12.1	13.21	12.41	13.9	0.77
Crude Fibre (g)	1.75	2.21	1.89	1.12	0.25
Total Ash (g)	1.05	1.32	2.1	1.52	0.07
Carbohydrate (g)	75	73	76	73	2
Energy (kcal)	429	427	432	437	22

*On dry matter basis

The fat content ranged from 12.10 to 13.90 g per 100 g in cookies. The fiber content in wheat flour cookies was 1.75g/100 g and it increased to 2.21 g/100 g in *Ragi*: Oats (50:50) and it decreased to 1.89 g/100g in *Ragi*: Oats (75:25) and 1.12 g/100 g in *Ragi*: Oats (100:00) cookies. The total ash content of wheat flour cookies was 1.05 g/100g which increased to 1.32 g/100g in *Ragi*: Oats (50:50), 2.10 g/100g in *Ragi*: Oats (75:25) and 1.52 g/100g in *Ragi*: Oats (100:00) cookies. The carbohydrate content and energy values ranged from 73 to 76 g/100g and 427 to 437 Kcal per 100 g (depicted in table 3).

Rana GK *et al.* 2021 [12] prepared by substituting maida i.e. sprouted *Ragi* millet four (SRMF) at 0, 05, 10, 15, 20 and 25% levels. They reported decrease in carbohydrate, protein, fat and energy value and increase in moisture ash and crude fibre. Supplementation of SRMF increases the overall acceptability with the highest score. They concluded that good quality of cookies can be prepared by substituting maida with SMRF 25% (GK Rana, 2021) [12].

A crispy snack *Sawan* Sticks made from *Sawan* flour (Little Millet or Barnyard Millet) with different flavours i.e., *Sawan* Flour with Curry Leaves, *Sawan* Flour Sticks with Moringa Leaves and *Sawan* Flour Sticks with Mint Leaves. The data represented in Table 4 regarding mean sensory score of crispy *Sawan* sticks revealed satisfactory significant difference among sensory scores. *Sawan* flour with mint leaves scored highest overall acceptability i.e. 8.63 i.e. were extremely liked by sensory panels. The mean sensory score of *Sawan* flour sticks with moringa leaves and curry leaves were 8.31 and 8.02 i.e. liked very much while plain *Sawan* flour sticks scored 7.03 i.e. liked moderately.

The table 5 showed the nutritional composition of crispy *Sawan* sticks. The *Sawan* flour sticks with mint leaves having highest sensory score contained 7.27g crude protein, 7.7g crude fat, 10.1g crude fibre, 3.75g total ash, 70g carbohydrate and 739kcal energy. *Sawan* flour sticks with moringa leaves having second highest score for sensory acceptability contained 8.10g crude protein, 6.87g crude fat, 10.5g crude fibre, 3.81g total ash, 68g carbohydrates and 366kcal energy. Kundgol and Kamatar M. Y. *et al.* 2013 [7] reported 7% protein, 4.26% fat, 678% carbohydrate, and 370 kcal energy in little millet grains (Kundgol & Kamatar, 2013) [7].

Table 4: Mean Sensory Score of Crispy *Sawan* Sticks on Nine Point Hedonic Rating Scale

Sensory Attributes/ Treatments	*Sawan* Flour Sticks	*Sawan* Flour Sticks with Curry Leaves	*Sawan* Flour Sticks with Moringa Leaves	*Sawan* Flour Sticks with Mint Leaves	CD (0.05)
Appearance	6.75	8.12	8.62	8.87	0.360
Color	7.12	8.37	8.50	8.75	0.33
Texture	7.50	7.62	8.12	8.37	0.49
Flavor	6.75	8.00	8.00	8.50	0.26
Overall Acceptability	7.03	8.02	8.31	8.63	0.26

Table 5: Proximate Composition of Crispy *Sawan* Sticks per 100g*

Treatments	Plain Sawan Flour Sticks	Sawan Flour Sticks with Curry Leaves	Sawan Flour Sticks with Moringa Leaves	Sawan Flour Sticks with Mint Leaves	CD (0.05)
Moisture (g)	4.55	4.01	2.88	1.15	0.21
Crude Protein (g)	8.74	7.11	8.1	7.27	0.38
Crude Fat (g)	7.15	5.16	6.87	7.79	0.21
Crude Fibre (g)	9.6	10.1	10.5	10.1	0.48
Total Ash (g)	2.9	4.24	3.81	3.75	0.25
Carbohydrate (g)	67	69	68	70	2
Energy (kcal)	368	352	366	379	17

*On dry matter basis

Ragi Makhana Booster is a powder containing *Ragi* and *Makhana* in different proportions. The data elicit in table 6 represents mean sensory score of *Ragi Makhana.* Booster containing *Ragi* and *Makhana* in different proportions i.e. 50:50, 75:25 and 100:0 varied significantly. Overall acceptability score of *Ragi*: *Makhana* (75:25) was the highest i.e. 8.50 (liked extremely). The *Ragi:* Mkhana (75:25) contained 7.84g crude protein, 0.44g crude fat, 5.4 g crude fibre, 1.32g total ash, 78 g carbohydrate and 348 kcal energy. *Ragi*: *Makhana* (50:50) and *Ragi*: *Makhana* (100:0) scored 6.75 and 7.5 i.e. liked moderately and liked very much. As the amount of *Makhana* (Fox chest nut) deceased in the booster mixture from 50-25%, the crude protein content also decreased significantly. 100 percent *Ragi* Booster powder contained lowest protein (7.32%). The fat content ranged

0.09g/100 g to 0.44g/100 g. The fibre content was found to be maximum in booster containing *Ragi*: *Makhana* (50:50) i.e. 6.9g/100g. The amount of *Makhana* decreased the fibre content also decreased. The ash content of mixture ranged from 1.27- 1.41g per 100 gram. As the amount of *Ragi* increased the total ash content also increased. Carbohydrate content ranged from 77 to 82 g per 100 gram while calorie value ranged from 346 to 356 Kcal per 100 g. 30 g of this booster powder needs to be dissolved in 250 ml of milk while drinking (illustrate in table 7).

Khwairakpam and Murugkar 2019 prepared 3 flavoured ready-to eat beverages using sorghum and finger millet as base material. These beverages were found acceptable to consumer with overall acceptability score above 7 on a 9 point hedonic scale.

Table 6: Mean Sensory Score of *Ragi Makhana* Booster on Nine Point Hedonic Rating Scale

Sensory Attributes/ Treatments	Milk	*Ragi*: *Makhana* (50:50)	*Ragi*: *Makhana* (75:25)	*Ragi*: *Makhana* (100:0)	CD (0.05)
Appearance	6.00	7.00	9.00	8.00	0.36
Color	7.00	7.00	8.00	8.00	0.34
Texture	6.00	7.00	9.00	7.00	0.32
Flavor	8.00	6.00	8.00	7.00	0.36
Overall Acceptability	6.75	6.75	8.50	7.50	0.34

Table 7: Proximate composition of *ragi makhana* booster per 100 g

Treatments	Milk Powder	Ragi: Makhana (50:50)	Ragi: Makhana (75:25)	Ragi: Makhana (100:00)	CD (0.05)
Moisture (g)	8.1	5.5	6.4	5.8	0.39
Crude Protein (g)	23.92	8.78	7.84	7.32	0.29
Crude Fat (g)	15	0.17	0.44	0.09	0.6
Crude Fibre (g)	0	6.9	5.4	3.8	0.2
Total Ash (g)	5.42	1.27	1.82	1.41	0.13
Carbohydrate (g)	48	77	78	82	4.5
Energy (kcal)	421	346	348	356	15.87

*On dry matter basis

Table 8: Cost of standardized products for ready to eat food products (Rs. 100 g)

Food Items	Treatments	Cost (Rupees per 100 gram)
Ragi Oats Cookies	Whole Wheat Flour	6.5/-
	Ragi: Oats (50:50)	12.1/-
	Ragi: Oats (75:25)	9.8/-
	Ragi: Oats (100:0)	7.82/-
Crispy *Sawan* Sticks	*Sawan* Flour Sticks	12/-/-
	Sawan Flour Sticks with Curry Leaves	12.5/-
	Sawan Flour Sticks with Moringa Leaves	12.5/-
	Sawan Flour Sticks with Mint Leaves	12.5/-
Ragi Makhana Booster	Milk Powder	12.5/-
	Ragi: Makhana (50:50)	28/-
	Ragi: Makhana (75:25)	17/-
	Ragi: Makhana (100:0)	6/-

The average cost of the developed products is presented in table 8. The cost of *Ragi*: Oats Cookies (50:50) was Rs. 12.1/ 100g which decreased to rupees 9.8 and 7.82 as the amount of oats decreased in *Ragi*: Oats (75:25) and *Ragi*: Oats (100:0). The cost of Plain Crispy *Sawan* Sticks was rupees 12 per 100 gram whereas sticks containing different flavours costs 12.5 per 100 gram. *Ragi: Makhana* Booster (50:50) costs rupees 28 and *Ragi: Makhana* (75:25) and *Ragi: Makhana* (100:0) costs less.

6. Conclusion

From this study, it can be concluded that acceptable ready-to eat food products for geriatric namely *Ragi* Oats Cookies (75:25), *Sawan* Sticks with mint flavor and *Ragi Makhana* Booster (75:25) can be prepared at home or may be commercialized. These products were found to be rich of protein, fibre and minerals as reasonable cost.

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