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Formulation of Roasted Sunflower Seeds (*Helianthus annuus* L.) Katli: A Promising Complementary Food for Children

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ABSTRACT: Human milk alone no longer can supply all of an infant's nutritional needs, and complementary foods are needed to ensure adequate nutrition and growth. It is commonly assumed that an increased need for energy and protein is the primary factor dictating complementary feeding, but some of the micronutrients are likely to become limiting sooner than the macronutrients. Meeting children's nutrient needs in early life can be challenging, and many parents face barriers to securing enough nutritious, safe, affordable and age-appropriate food for their children. Another challenging feature is that changing lifestyle and food habits where children are often fed with synthetic and processed food rather than nutritious foods leading to chronic health conditions. A complementary food sunflower seeds Katli is therefore designed to provide nutrient-dense, safe, low cost food from the combination of sunflower seeds, germinated wheat and green gram flour, jaggery and ghee. The Sunflower Seeds Katli was prepared with soaked and roasted formulations of (20%), (30%) and (40%). The sensory evaluation score of roasted Sunflower seeds Katli (30%) variation was found promising for appearance, colour, texture, flavour, taste and over acceptability was 8.52, 8.55, 7.56, 8.56, 8.58respectively. The nutritional composition of roasted sunflower seeds Katli (30%) was analyzed and found that the moisture content was 3.31 g, protein 15.47g, fat 10.49g, ash 1.96g, crude fibre 5.17g, carbohydrates 79.64g, energy 454 Kcal, potassium 260 mg, iron 20 mg, magnesium 275 mg and polyphenols 60.12 mg. The values indicate that roasted sunflower seeds Katli (30%) is a very good source of nutrients for the growth and development of children. Therefore, formulations based on locally available produce having no harmful effect on the health of children, is the need of the hour.

Keywords: Sunflower seeds Katli, Complementary foods, Sensory Evaluation and Nutritional composition.

INTRODUCTION

Human milk alone no longer can supply all of an infant's nutritional requirements, and complementary foods are needed to ensure adequate nutrition and growth. It is commonly assumed that an increased need for energy and protein is the primary factor dictating complementary feeding, but some of the micronutrients are likely to become limiting sooner than the macronutrients (Dewey, 2001). If a mother nurses on demand and is well nourished, her milk supply probably can keep pace with her infant's energy needs for considerably longer than 6 months. By contrast, the amount of iron provided by human milk may become insufficient even before 6 months if an infant has suboptimal iron reserves at birth (Black *et al*., 2013).

Poor complementary feeding practices (CFP) have been linked to increased risks of respiratory and gastrointestinal infections, underweight and mortality (Davies and Adetugbo 1997).

The term weaning comes from the Anglo-Saxon word "wenian" meaning "to become accustomed to something different". Weaning from the breast is a natural, inevitable stage in a child's development. It is a complex process involving nutritional, immunological, biochemical and psychological adjustments. Weaning may mean the complete cessation of breastfeeding ('abrupt' or final wean) or the beginning of a gradual process of the introduction of complementary foods to the infant's diet (Adenuga, 2010).

WHO/UNICEF, (2007) emphasizes the use of local foods formulated in home and keep following principles under consideration for formulating a weaning product: (i) high nutritional value to supplement breast feeding, (ii) acceptability, (iii) low price, (iv) use of local food items and of suitable consistency. During formulation of weaning foods made from locally available raw materials, the techniques of food processing, storage and distribution; socio-economic status; cultural and religious factors; sensory properties and food quality and safety issues should be considered.

The types of food selected for complementary feeding and its timing are critical to ensure the optimal growth

and development of young children. The period from 6 to 24 months of life marks a stage of rapid growth, with additional nutrient requirements imposed by a poor environment, which could magnify the deficiencies of a poor-quality diet. In low- and middle-income countries, survey data consistently show that complementary diets lack diversity, with the consumption of a minimally acceptable diet in children aged 6–23 months being as low as 3 per cent (WHO, 2010).

Adequate and balanced energy, macronutrient and micronutrient intakes are vital for the physical and mental development of in fants and children. Prevention and treatment of child under nutrition require diets providing adequate energy and essential nutrients to promote catch-up growth in weight and height, strengthen resistance to infection, and support normal mental, physical and metabolic development (Cusick and Georgieff 2016). In addition to the challenges in procuring dietary diversity and in consuming adequate amounts to meet nutrient intake recommendations, the commonly consumed foods such as cereals, legumes and oil seeds, are known to be relatively high in anti-nutrient content and have low nutrient bioavailability for some nutrients such as Fe, Zn and vitamin A. (Aderonke *et al.*, 2014).

Nutritional supplementation and food fortification are therefore recommended for achieving a desired nutrient density and nutrient adequacy to promote growth in children with under nutrition. Meeting children's nutrient needs in early life can be challenging, and many parents face barriers to securing enough nutritious, safe, affordable and age-appropriate food for their children. The unavailability of nutritious food is one of the main causes of protein energy malnutrition (PEM) in children in the developing countries (Balasubramanian *et al.*, 2014).

Therefore, formulations based on locally available produce having no harmful effect on the gastro intestinal tract of infants, is the need of the hour. A supplementary food is therefore designed to provide nutrient-dense, safe, low cost food from the combination of sunflower seeds, germinated wheat and green gram flour, jaggery and ghee.

MATERIALS AND METHODS

Procurement of Raw Materials. The food commodities –sunflower, wheat, green gram, jaggery, cardamom and ghee were used to formulate the complementary food. All the ingredients were purchased from local markets of Bengaluru. The diets were prepared by blending all the ingredients in different proportions. Sunflower seeds, wheat and greengram were used as major ingredients of the mixture. Protein source was derived from these grains; fat source from the oil seeds, jiggery as the sweetener to enhance the accept ability and with ghee to make the formula calorie-dense.

Preparation of Ingredients

Germination of wheat and greengram.

Cleaning: Wheat and green gram was purchased from local market, cleaned to remove extraneous material. Cleaning was done by hand sorting.

Steeping/soaking: The cleaned wheat and green gram were washed twice in excess portable water. Then, the cleaned and washed grains were soaked in a volume of water 3 times the weight of seeds (3:1) for 12 hours in a container at ambient temperature (Gernah *et al.*, 2011).

Sprouting: The traditional sprouting procedures were adapted to laboratory conditions as follows: the steeping water was drained off and the soaked wheat and green gram were washed twice using portable water to prevent the growth of microorganisms during sprouting. The soaked grains were wrapped in damp muslin cloth to stimulate sprouting. The grains were allowed to sprout for 24 hours. The sprouts were dried in hot air oven for 6 hours at 60ºC (Elkhalifa and Bernhardt 2010).

Roasting of grains: The grains were roasted in a thick based pan until the seeds turned slightly golden brown in colour. The seeds were allowed to cool and were then ground in an electric mixer (Van, 2005).

Milling: The roasted grains were ground in an electric grinder to make fine powder. The milled sample was then packed in airtight plastic covers. The packed covers was stored at room temperature until further use.

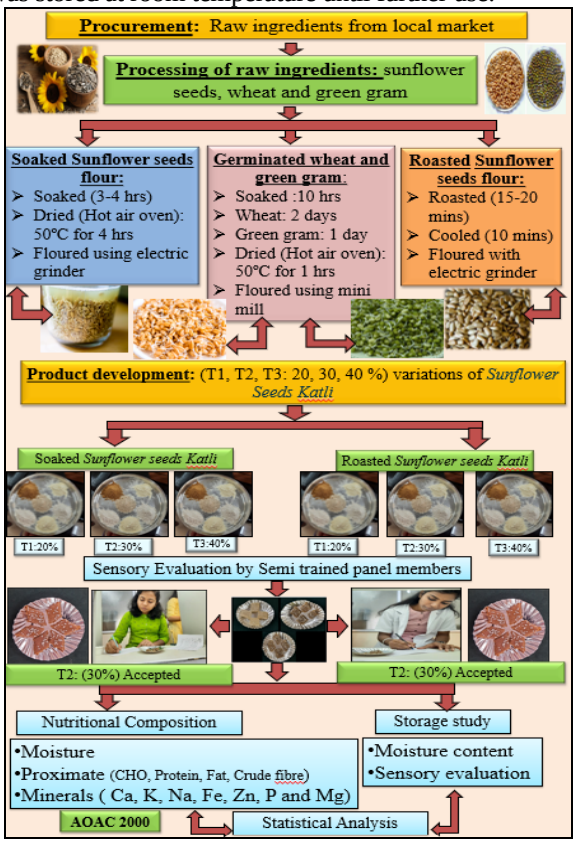

Fig. 1. Study design.

Formulation of complementary food. The formulation of complementary foods is generally based on this assumption that the child consumes an average of 100g per day. The formulation of complementary food was developed from sunflower seeds, wheat, green gram, jaggery, cardamom and ghee. All ingredients were added and roasted along with ghee to obtain desirable product.

Table 1: Formulation of sunflower seeds Katli.

Variations	Sunflower seeds flour (g)	Sprouted wheat flour (g)	Sprouted Green gram flour (g)	Jaggery powder (g)	Ghee (ml)	Cardamom powder (g)
T1	20	15	15	20	30	2
T2	30	15	15	20	20	2
T3	40	15	15	20	10	2
T- Soaked and roasted sun flower seeds powder						

Sensory evaluation of developed sunflower seeds Katli. Sensory (organoleptic) evaluation was carried out using nine-point hedonic scale. The scorecard developed for evaluation was based mainly on the appearance, colour, texture/consistency, taste and overall acceptability. Semi trained judges having good health status and interested in sensory evaluation were selected from Department of Food Science and Nutrition, UAS, GKVK, Bengaluru. The panel members were briefed about the product and were instructed individually to evaluate the product.

Nutritional analysis. The developed product's nutritional composition was analyzed or estimated using standard method (AOAC, 2000) in the laboratory of Department of Food Science and Nutrition, UAS, GKVK, Bengaluru. The product was analyzed for the parameters such as moisture, protein, fat, ash, crude fibre, total polyphenols. Minerals such as calcium, iron, magnesium, manganese, phosphorous, potassium, sodium and zinc will be estimated. Carbohydrates and energy were calculated using the formula method.

Cost estimation of the best accepted sunflower seeds Katli. The method adopted for economic analysis was as per Gastel (2005). Basic cost of raw ingredients used for product preparation was calculated on the current cost at the time of preparation of the raw ingredients in the wholesale commercial market. For calculations of cost price, 50 per cent of basic cost was added as overhead charges to this and the total cost was 12 considered as the production cost. The selling price was calculated by adding 25 per cent profit to production cost. The experimental product could be sold easily at a premium rate. Therefore, a premium-selling price was calculated with additional marginal premium charges of just 10 per cent more than normal selling price and expressed as percent of extra income gained as compared to the control product.

Statistical analysis. In the present study one-way ANOVA was applied. The data was tabulated and analyzed by keeping in view of the objectives and parameters of the study. All the analyses were performed in triplicate and the data was analyzed using EXCEL.

RESULTS AND DISCUSSION

Table 2: Formulation of sunflower seeds Katli.

Ingredients	T1 (20%)	T2 (30%)	T3 (40%)
Sunflower seeds flour (g)	20	30	40
Sprouted wheat flour (g)	15	15	15
Sprouted Green gram flour (g)	15	15	15
Jaggery powder (g)	20	20	20
Ghee (ml)	30	20	10
Cardamom powder (g)	2	2	2

T- Soaked and Roasted sun flower seeds powder. The formulation of complementary food (Table 2) was developed from sunflower seeds, wheat, green gram, jaggery, cardamom and ghee. All ingredients were added and roasted along with ghee to obtain desirable product. As sunflower seeds are oil seeds in general, incorporation of it to any food product has been based on its oil content. Hence, the incorporation was in three different variations ranging from (20%, 30% and 40%) and kept other ingredients at constant. The formulation of the developed sunflower seeds Katli was standardized to 100±2g. The similar work was carried out by Srivastava and Verma (2014) where Three value added products namely 'Laddoo', 'Biscuit' and 'Missi roti' were made by incorporating sunflower seeds flour at 15 percent, 25 percent and 35 percent level refers as T1, T2, T3 respectively and the control T0 for all the prepared products was made without the incorporation of sunflower seeds flour.

Sensory evaluation. Table 3 and 4 depicts the sensory score of the soaked and roasted sunflower seeds Katli (SSSK and RSSK). Organoleptic evaluation based on 9-point hedonic scale and 21 semi trained panel members was done to control Kaaju Katli and sunflower seeds Katli variations and the attributes like appearance, colour, texture, flavour, taste and over acceptability was seen. The score for like appearance, colour, texture, flavour, taste and over acceptability was 8.52, 8.55, 7.56, 8.56, 8.58 respectively. Appearance of the Katli was soothing. It was found from the sensory evaluation that the texture was slightly gritty and could have been finely powdered. Katli was light green in colour due to the sunflower seeds powder. Soaked variations had slight off flavour compared to the roasted ones. The similar work on development of sunflower seeds chikki was developed and analysed for sensory attributes by Muttagi *et al.* (2014) which revealed that the products which were developed from roasted sunflower seeds had higher sensory acceptance at (30%) incorporation into the product compared to control taken as ground nut chikki. The Fig. 2 indicated the mean sensory score of roasted sunflower seeds Katli. Roasting helped to avoid off flavour and hindered the activity of antinutrient like phytates.

Table 3: Mean sensory score of soaked sunflower seeds Katli.

Variations	Appearance	Colour	Aroma	Texture	Taste	Overall acceptability
T0(Control)	8.47±0.83	8.86±0.69	8.36±0.32	8.52±0.79	8.30±0.13	8.5±0.61
T1 (SSSK)	7.99±0.82	7.60±0.78	7.52±0.66	7.21±0.85	7.69±0.87	7.73±0.86
T2 (SSSK)	7.02±0.94	7.35±0.77	7.26±0.78	7.36±1.03	7.46±0.78	8.08±0.73
T3 (SSSK)	8.17±0.83	7.86±0.69	7.56±0.72	7.52±0.79	7.60±0.83	8.00±0.73

Table 4: Mean sensory score of roasted sunflower seeds Katli.

Variations	Appearance	Colour	Aroma	Texture	Taste	Overall acceptability
T0(Control)	8.47±0.83	8.86±0.69	8.36±0.32	8.52±0.79	8.30±0.13	8.5±0.61
T1 (RSSK)	7.69±0.82	7.40±0.78	7.33±0.66	7.37±0.85	7.41±0.87	7.53±0.86
T2 (RSSK)	**8.52±0.94**	**8.55±0.77**	**7.56±0.78**	**8.56±1.03**	**8.56±0.78**	**8.58±0.73**
T3 (RSSK)	8.17±0.83	8.36±0.69	7.56±0.72	8.52±0.79	7.60±0.83	8.00±0.73

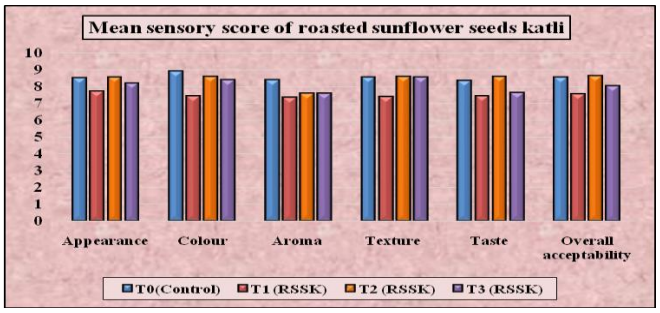

Fig. 2. Mean sensory score of roasted sunflower seeds Katli.

Table 5: Proximate composition of Roasted Sunflower seeds Katli (100 g).

Proximate	Roasted Sunflower seeds Katli per 100 g		
	Control (Kaaju Katli)	Sunflower seeds Katli	FSSAI Specifications
Moisture (g)	9.27±0.10	8.92±0.06	≤12.00
Fat (g)	18.22±0.09	12.90±0.10	≥10
Protein (g)	9.82±0.05	10.13±0.70	2.00
Ash (g)	1.25±0.12	1.96±0.10	7.50
Crude fibre (g)	0.61±0.43	1.42±0.46	2.00
*Carbohydrate (g)	15.59±0.69	53.03±1.01	55
*Energy (Kcal)	162.67±1.9	198.78±1.74	-

Values are mean of triplicates ± SD, *Carbohydrate-difference method *Energy-computation

Proximate composition of roasted sunflower seeds Katli. The nutritional composition of roasted sunflower seeds Katli is indicated in Table 5. The moisture 5.31 g, protein 13.47g, fat 10.49g, ash 1.96g, crude fibre 2.17g, carbohydrates 79.64g, energy 454 Kcal and polyphenols 120.12 mg. The developed product's proximate composition was compared with FSSAI specifications (2017) for weaving foods and complementary foods. The values indicated that roasted sunflower seeds Katli was a very good source of nutrients for the normal growth and development of preschool children, because Katli was rich in energy, carbohydrates, protein and other nutrients compared to control and also it was in set limitation of the FSSAI standards. The analogous study was undertaken by Grasso *et al.* (2020) where the sunflower seeds based muffins were developed for children with (30%) replacement of wheat flower and that met the complementary food requirement of children according to set standards of FSSAI. Major nutrients composition of control and treatment was indicated in the Fig. 3.

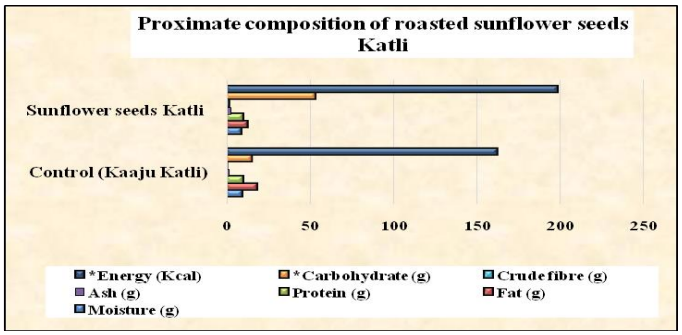

Fig. 3. Proximate composition of control and treatment.

Mineral composition of roasted sunflower seeds Katli. The minerals composition of roasted sunflower seeds burfi is presented in Table 6. It was noticed that roasted sunflower seeds Katli was the store house of minerals. The total ash content of roasted sunflower seeds Katli inthepresentstudywas1.96gi n which the calcium content was 57.17mg, phosphorus 189.33 mg, sodium 8.16 mg, magnesium 133.47 mg, potassium 206.95 mg, iron 15.79mg and zinc 2.79mg. The mineral composition met the requirement of the children which is rarely met by the milk consumption. The parallel investigation was conducted by Vasudha and Sarla (2021) where they assessed the nutritional quality of the cake developed from sunflower seeds revealed that the product was rich in minerals and catered the needs of children which was deficient in milk consumption.

Table 6: Mineral composition of roasted sunflower seeds Katli (100g).

Micronutrients	Roasted Sunflower seeds Katli per 100 g		
	Control (Kaaju Katli)	Sunflower seeds Katli	FSSAI Specifications
Calcium (mg)	15.24±0.20	25.12±0.01	-
Magnesium (mg)	45.22±0.09	85.63±0.42	-
Phosphorous (mg)	86.82±0.05	167.13±0.70	-
Sodium (mg)	1.55±0.12	0.2±0.02	-
Potassium (mg)	97.61±0.43	178.42±0.46	-
Iron (mg)	05.59±0.69	2.03±1.01	3.00-5.65
Zinc (mg)	0.3.67±1.9	1.78±1.32	2.50-5.90

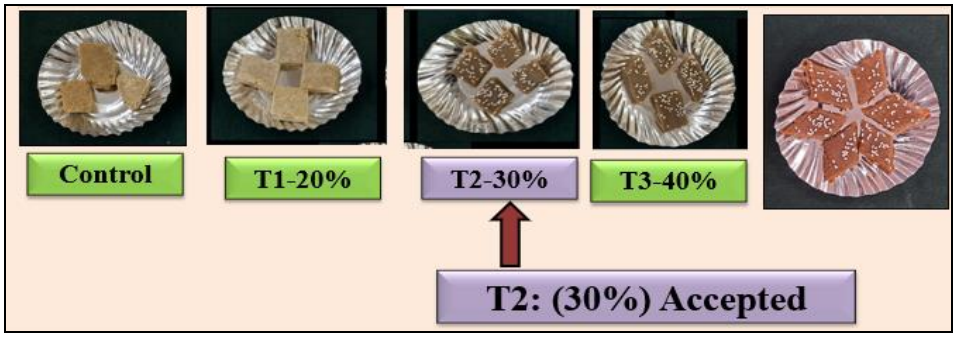

Plate 1: Development of Roasted Sunflower seeds Katli.

Table 7: Cost economics of roasted roasted sunflower seeds Katli.

Ingredients	Qty (g)	Rate (Rs.) / kg	Cost (Rs)
Sunflower seeds (g)	30	85	18.5
Sprouted wheat flour (g)	15	50	2.5
Sprouted Green gram flour (g)	15	100	2.5
Jaggery powder (g)	20	100	2.00
Ghee (ml)	20	450	9.00
Cardamom powder (g)	2	300	1.5
Total	100	1008	36.00
Overhead charges @25%	9.00		
Profit (10%)	4.50		
Cost of the product	49.52~50		

The cost of any product depends upon a number of variable factors like cost of raw materials, cost of processing and packaging of the product, *etc*. Here, the approximate cost of best accepted products (per 100gm) is indicated. Overhead charges at 25 per cent of expenditure on manufacturing, which includes labour cost, depreciation cost on machinery, equipment, building etc., and profit at 10 per cent was included. The results revealed that the total production cost was found to be Rs. 50 per 100g. (Table 7). The method adopted for economic analysis was as per Gastel (2005). Compared to the control, developed product was affordable and met the needs of the children and also often much liked for consumption.

CONCLUSIONS

The study revealed that the roasted sunflower seeds Katli, which contains (30%) sunflower seeds flour, was approved. Sensory evaluation and moisture content testing showed that the product had excellent keeping qualities. Weaning foods are made to provide nutrient-dense, safe, low-fat nutrition for infants and young children because improved complementary feeding with reduced morbidity is necessary to achieve the Millennium Development Goals (MDGs) for child survival and the prevention of malnutrition.

FUTURE SCOPE

There is a need for wide spread knowledge on developing nutritious complementary foods. As discussed it has functional parameters and nutritive value, it imprints as the golden standard to combat nutrient deficiencies and to fight protein energy and also micro nutrient deficiencies in young growing children. Further research has to be carried on more

variety of complementary foods with nutritional and palatability benefits.

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Conflict of Interest. None.

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