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Optimization of Extruded Snack Enriched with Coconut Inflorescence Sap Honey: A Promising Supplementary Food among Tribals

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ABSTRACT

Background: Development of low-cost nutrient dense supplementary foods are a priority for health system in low- and middle-income countries. Extrusion technology has obtained widen acceptance for the production of various products *viz*., breakfast cereals, puffed snacks and pastas etc. Nevertheless, it is necessary to enhance the nutritional quality of the extruded snacks by including nutrient dense ingredients. In this study, an extruded snack using finger millet, whole wheat, tapioca, chickpea and coconut inflorescence sap honey were developed with aim to enhance the nutritional status of children residing in tribal pockets of Kasaragod district of Kerala, India.

Methods: The ideal combination of ingredients was optimized using response surface methodology. The ideal combination with maximum expansion ratio was selected for supplementation trial. The nutrient analysis of optimized extruded snack was carried out.

Results: Hundred grams of extruded snack consists of 28 per cent of finger millet, 24 per cent corn starch, 18 per cent of chickpea, 18 per cent of tapioca, 12 per cent of whole wheat and 12 per cent of coconut sap honey. Apart from the major ingredients, per 100 grams of the optimized snack provides 22.11 grams of protein, 60.71 g of carbohydrate, 5.09 g of fiber, 127.4 mg of calcium and 1.88 mg of zinc. Two hundred grams of the extruded snack per packet per individual were distributed to 250 tribal households of Kasaragod district where one of the particularly vulnerable tribal groups named 'Koragas' exists.

Key words: Chickpea, Coconut inflorescence sap, Extruded snack, Finger millet, Koragas, Neera, Tribes.

INTRODUCTION

According to latest comprehensive national nutritional survey (2016-2018) conducted in India, around 33 per cent of children under five were under weight with prominent symptoms of stunting (35 per cent) and wasting (17 per cent) (MoHFW, 2019). Likewise, anaemia (32 per cent of pre-schoolers' have low serum ferritin levels) and other micronutrient deficiencies (23 per cent of pre-schoolers' and 28 per cent school aged children had folate deficiency) were also observed with a higher prevalence among children belonging to scheduled tribes (42 per cent) and scheduled castes (36 per cent) (MoHFW, 2019). Poverty along with poorly functioning food systems, health and social environments can result in limited access to nutrient dense foods (WHO, 2017). Likewise, the current supplementary rations are provided to children up to three years of age. Hence, it is difficult to ensure nutritional security of the pre-schoolers and school going children belonging to the rural and tribal communities.

The food consumption pattern of the tribals is mostly skewed towards carbohydrates, mainly rice based, with meagre pulses, vegetables, fruits, and tubers (UNICEF). Promising efforts are required to enhance dietary diversity through utilizing the indigenous crops, forest's untapped resources *etc*. In this regard, efforts need to be done to inculcate indigenous nutrient dense foods in the form of supplementary foods. Unfermented inflorescence sap from coconut is one such indigenous food ingredient which is rich in vitamins and minerals, it is popularly known as 'Neera' in India, 'Raa' in Sri Lanka and 'Tuba' in Philippines. The sap is collected and consumed as such, further it is also processed and made into several value-added products like neera sugar, neera honey, neera jaggery *etc*. All of these are relished in various indigenous dishes owing to its rich nutritional and therapeutic profile (Asha *et al*., 2019).

Cereals, mainly maize or rice are generally utilized to contribute the energy density of the supplementary foods, while protein concentrates or isolates in the form of whey

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powder or skim milk powder are added as a source of protein (Onwulata and Konstance, 2002; Ghavidel and Prakash, 2010). Hence synthesis of cost effective nutrient rich supplementary formula has always been a concern for low-income countries. The govt. policies provide the tribal population with rice (35 kg/month/family) as major staple; however, their tracks are land to several nutri-cereals like finger millet (ragi), tubers, fruits, vegetables, and uncultivated medicinal greens (Prabhu, 2019). Native crops like millets can counteract malnutrition and micronutrient deficiencies (Anitha *et al*., 2022).

Extrusion technology has been widely used for the preparation of third generation snacks and its application in production of supplementary foods is highlighted by many researches (Bukusuba *et al*., 2008; Balasubramanian *et al*., 2014; Ali *et al*., 2016), however refined flours are used extensively in these types of snacks due to their better extrusion properties to produce products with more expansion and less density. Enrichment of extruded snacks using functional ingredients *viz.*, tomato skin (Dehghan-Shoar *et al*., 2010), fruit powders (Potter *et al*., 2013), banana flour, bean flour (Sarawong *et al*., 2014) *etc*. are been carried out recently to enhance the nutritional value of the extruded snacks. Likewise, recent researches identified the application of legumes for healthier snacks, however more lab-scale researches are warranted to optimize ideal combination of the legumes (Tas and Shah, 2021).

Refined sugars are mainly used as sweetening agent in the extruded snacks. Hence this category of snacks increases the empty calories without any vitamins, minerals, or dietary fibre. Coconut sap honey is an ideal sugar substitute with low glycemic index (<55), it is produced by concentrating the fresh inflorescence sap either using vacuum evaporation or convectional heating mechanisms until the sap reaches 78-degree brix (Hebbar *et al*., 2022). Therefore, the current study was carried out with the objective to analyse the application of legumes like chickpea, tubers like tapioca and finger millet in optimization of a supplementary extrudate enriched with coconut inflorescence sap honey.

MATERIALS AND METHODS

Conceptualization of the work

The idea to optimize an extruded snack using finger millets, whole wheat, chickpea, tapioca, coconut starch and coconut sap honey was initiated as part of the research objective to enhance the nutritional status of tribal population at Kasaragod district of Kerala, under the Indian Council of Agricultural Research (ICAR) funded Tribal Sub-Plan (TSP) implemented at College of Agriculture, Padannakkad, Kerala Agricultural University in the year 2021-2022. To the best of our knowledge, present study is the first of its kind, which analysed the possibility of inclusion of coconut inflorescence sap honey in extruded snack as substitute to sucrose. Currently, powdered weaning mix is distributed through ICDS, in the state of Kerala, to enhance the nutritional status of children belonging to the age group of six months to three years. As indicated previously, it was evident from the latest comprehensive national nutrition survey 2016-2018, that the school going children are also facing deficiencies and hidden hunger. Nevertheless, powdered weaning mix has least acceptance among the school going children. In this regard, the research team came up with an idea to optimize an extruded snack which offers nutrients alongside satisfying their palatability.

Selection and preparation of ingredients

The following ingredients *viz.*, finger millet (*Eleusine coracana*), cassava (*Manihot esculenta*), chickpea (*Cicer arietinum*), whole wheat and corn starch were chosen to prepare the extruded snack with an aim to diversify the staples in the supplementary food using the indigenous crops in tribal settlements. Each ingredient was procured from local market, cleaned, processed separately and then pulverised into flour for using in extrudate preparation. The flours were sieved using 0.25 mm mesh screen before extrusion. Coconut sap honey was obtained from the sap processing plant located at College of Agriculture Padannakkad of Kerala Agricultural University, Kasaragod, Kerala, India. Since the extrudate is designed to consist of cereals, nutri-cereals, pulses, and tubers along with coconut sap honey, the ideal ingredient combination was optimized using response surface methodology.

Experimental design

According to the preliminary trials, among the five ingredients under consideration, finger millet, chickpea flour and corn starch were found to be the major ingredients that influence the physical attributes *viz*., expansion ratio and bulk density of the final extrudate. An inscribed three factor central composite design (CCD) with 20 runs including 6 central points were used for the experimentation. The three factors were finger millet (15-30 per cent), chickpea flour (5-15 per cent) and corn starch (15-30 percent) and two response variables were expansion ratio and bulk density (Table 1). The minimum and maximum levels of the factors were fixed based on preliminary lab trials. The proportion of other ingredients *viz*., tapioca and whole wheat flour were taken at a ratio of 2:3 to the total quantity of ingredients.

Physical properties of extrudates

Bulk density

Bulk density of the extrudate was measured using the formula:

$$\rho = \frac{w}{\pi\, d^2 * l/4}$$

where,

ρ = Bulk density (g/cm^3).

w = Weight of a cylindrical section of extrudate,

d (cm) = Diameter of the extrudate

l (cm) = Length of the extrudate.

The recorded observations are average values of 10 randomly measured extrudates were obtained (Barret and Peleg, 1992).

Expansion ratio (mm)

Expansion ratio indicates the degree of puffiness of the sample on extrusion process, it is calculated based on the ratio between the diameter of the extrudate, measured using vernier callipers, to the diameter of the die (Chakraborty *et al*., 2009).

Extrusion parameters

The extrusion process was carried out using a laboratory scale twin screw extruder (SLG65-IV Extruder) from KK Lifesciences, Chennai, India available at ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala. The four zones of extrusion barrel were maintained at 40°C, 53°C, 86°C and 114°C. The speed of the main screw was maintained at 35 Hz feeder speed at 17 Hz and the cutting speed at 8 Hz. Real time moisture of the feed in each batch was recorded using digital moisture meter and adjusted to 22 per cent with the addition of coconut sap honey to the ingredient blends at 12 per cent.

Chemical analysis

The proximate analysis *viz*., protein (micro-Kjeldahl method), crude fiber (enzymic-gravimetric method) and fat (Soxhlet method) was carried out by AOAC method of analysis (2006). The total carbohydrate was determined using anthrone reagent method (Sadasivam and Manikam, 1992).

Elemental analysis

The essential elements in the extrudate were analysed using an inductively coupled plasma optical emission spectrometer (Analytik Jena ICP OES, model-'plasma Quant PQ 9000') equipped with a peristaltic pump, nebulizer coupled to a cyclone spray chamber and a control torch made up of quartz glass with an injector diameter of 2.0 mm. the instrument has a UV-sensitive semiconductor detector. Argon is used as the operating gas and the entire system is controlled with aspect PQ1.3.0.0. software. The instrument operating conditions were sample flow rate: 1 ml/min, radio frequency power: 1200 w, plasma argon flow rate: 15 L/min, auxiliary argon flow rate: 0.50 L/min, nebulizer gas flow rate: 0.50 L/min. 0.5 g of powdered extrudate was digested with 15 ml conc. HNO_3 and 30 per cent H_2O_2 followed by hot plate digestion for 30-60 minutes at 80°C. Digested samples were filtered and the volume were made up to 50 ml using distilled water followed by quantification of zinc and calcium. The instrument facility was available at the Precision analytical CAAST lab, College of Agriculture, Padannakkad established as part of the ICAR NAHEP project and the protocol for sample digestion and analysis were standardized by the authors.

The proximate composition and micro nutrients were also determined for a supplementary weaning mix (in the brand name 'amrutham nutri-mix') distributed under ICDS scheme (Integrated Child Development Services) through Anganwadi centres as part of the child nutrition program was taken as control and compared with the nutrient composition of the extruded snack developed in the current study. Hundred grams of this supplementary-mix (control) contains wheat (45 per cent), Bengal gram (15 per cent), ground nut (10 per cent), soy defatted (10 per cent), sugar (20 per cent).

Estimated Dietary Intake (EDI) and percent of Nutrient Contribution (NC)

The estimated dietary intake of each nutrient from the extruded supplementary snack and the control nutri-mix supplementary food were calculated using the content of each nutrient determined in our study against the customarily consumed quantity, which in this case the authors fixed as 25 grams. The portion size for consumption was fixed by refereeing to provisions made by supplementary nutrition program Andhra Pradesh state in India wherein they provide similar quantity of ready-to-eat snack food for children (http://www.icds-wcd.nic.in/icdsimg/review 051209/snp-ap.htm). The per cent nutrient contribution was estimated based on the ratio of EDI to the estimated average requirement (EAR) of each nutrient as specified by ICMR for children of 4-6 years of age.

Statistical analysis

A second order polynomial equation was fitted to determine the influence of variables on expansion ratio:

$$Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta11X1 + \beta22X2 + \beta33X3 + \beta12X1X2 + \beta13X1X3 + \beta23X2X3$$

Where,

$\beta0$ = Intercept.

$\beta1$, $\beta2$ and $\beta3$ = Coefficient of X1, X2 and X3, $\beta11$, $\beta22$, $\beta33$, $\beta12$, $\beta13$, $\beta23$ being the quadratic and interactive regression coefficients.

The data was analysed using RSM package in R.

Student's t-test was used to identify significant difference in the nutrient composition of extruded supplementary snack and control supplementary mix (Amrutham nutri-mix). All statistical analysis were performed using grapesAgri1 package in R (Gopinath *et al*., 2020).

RESULTS AND DISCUSSION

Optimization of ingredient combinations for ideal extrudate

The effect of different combinations of finger millet, chickpea and corn starch and the respective expansion ratio thus obtained were fitted to a second order model and the goodness of fit was examined. Analysis of variance was performed to understand the significance of linear, quadratic and two-way interactions of the different ingredient blends in the expansion ratio. As provided in the ANOVA (Table 2) quadratic model is significant except the interaction. Since eigen values are 0.12855812, 0.04307445, -0.08665623, stationary point is a saddle point (Fig 1). Thus, ridge analysis was performed to identify possible maximizing values. Canonical path analysis was performed by starting at the saddle point and follow the most steeply rising ridge in both directions. Possible candidate values *viz*., 28.48 percent (finger millet), 18.19 per cent (chickpea) and 23.55 per cent (corn starch) with expected expansion ratio of 3.92 is selected for further experimentation. Thus, the actual extrusion was carried out with 28 per cent (finger millet flour), 18 per cent (chickpea flour) 24 per cent (corn starch), 12 per cent whole wheat flour and 18 per cent tapioca flour and the experimental value of the expansion ratio for this combination was 3.98 mm.

Expansion ratio

The expansion ratio indicates the puffiness of the extrudate ranged from 2.83mm to 3.76 mm for the twenty trial runs. Ridge analysis was performed to identify the possible ingredient combination that can maximize the expansion ratio of the extruded snack while maintaining finger millet as the major ingredient. The expansion ratio of the finally selected combination of 28 per cent (finger millet flour), 18 per cent (chickpea flour) 24 per cent (corn starch), 12 per cent whole wheat flour and 18 per cent tapioca flour was 3.98. Since the selected combination contain ingredients *viz*., finger millet whole wheat and chick pea in higher proportion it enhances the fiber and protein content of the extrudate. Studies have revealed that high fiber and protein ingredient combinations can enhance the expansion ratio and positively enhance the textural properties of the extrudate when added to starch based raw materials (Đurđica *et al*., 2018).

Bulk density

Bulk density is a crucial factor in producing extruded products. During the extrusion process, expansion is measured by means of bulk density (Pardhi *et al*., 2016; Filli *et al*., 2013). The bulk density was found to be ranged from 0.171-0.31 c/cm3 for the twenty trial runs. The ANOVA (Table 2) revealed that the highest expansion ratio was discovered at 3.76 mm, which corresponds to a bulk density of 0.15 g/cm3. From the data, it is evident that lower bulk density and higher expansion ratio both result in a reduction in product hardness through increasing porous nature of the extrudate. Previous research has indicated that the moisture content of the feed in finger millet flours can have a reducing effect on the bulk density of the final extrudate (Nishani *et al*., 2017). The relationship between feed

Table 1: Central composite rotatable design with coded values of independent variables and experimental result of response variables.

Expt.	Variable levels			Responses	
no.	Corn starch	Chickpea	Finger millet	Expansion ratio (mm)	Bulk density (g/cm^3)
1.	-1	-1	-1	3.3	0.171
2.	1	-1	-1	3.13	0.123
3.	-1	1	-1	3.4	0.211
4.	1	1	-1	3.06	0.310
5.	-1	-1	1	3.03	0.280
6.	1	-1	1	3.23	0.255
7.	-1	1	1	3.5	0.214
8.	1	1	1	3.41	0.189
9.	-1.682	0	0	2.83	0.302
10.	1.682	0	0	3.26	0.217
11.	0	-1.682	0	3.33	0.193
12.	0	1.682	0	3.76	0.154
13.	0	0	-1.682	3.43	0.210
14.	0	0	1.682	3.26	0.187
15.	0	0	0	3.23	0.216
16.	0	0	0	3.16	0.220
17.	0	0	0	3.19	0.259
18.	0	0	0	3.23	0.208
19.	0	0	0	3.16	0.195
20.	0	0	0	3.2	0.180

Table 2: ANOVA for the fit of experimental data to response surface model.

	Df	Sum Sq	Mean Sq	F value	Pr (>F)
FO (x1, x2, x3)	3	0.15183	0.050609	3.2896	0.06
TWI (x1, x2, x3)	3	0.12255	0.040850	2.6553	0.10
PQ (x1, x2, x3)	3	0.28228	0.094093	6.1161	0.012
Residuals	10	0.15385	0.015385		

Multiple R-squared: 0.7835, Adjusted R-squared: 0.5886.

moisture and bulk density can be significant. Bulk density may increase due to increased feed moisture (Filli *et al*., 2010). Screw speed, moisture content, as well as barrel temperature all had a positive linear impact on the bulk density of extrudates. An increase in fiber content may have a positive impact on the product's bulk density. As a result, increased finger millet flour may have an impact on bulk density (Nagaraju *et al*., 2020). The finger millet content is limited to 28.48%, and the remaining components weigh the rest, so the bulk density might be reduced.

Nutrient composition

The nutritional profile of the extruded supplementary snack and the supplementary nutritional mix was compared (Amrudham nutritional mix, developed and distributed by anganwadi centres under the ICDS programme) (Table 3). The Amrutham Nutrimix is a dietary supplement that the government of Kerala distributes to young children under the age of three as an additional source of nutrition. The mixture, which is typically served to kids as porridge to get all the nutritional benefits. Since school-going children over the age of three years would not enjoy eating the nutritional mix in the form of porridge, we are likely to adopt the supplementary nourishing extruded product in the form of snacks. The nutrient composition along with essential elements *viz.*, calcium and zinc content of the optimized nutri-snack was determined. The energy of the nutri-mix and the extruded nutri-snack was calculated by considering the calories obtained from protein, fat, carbohydrate, and dietary fiber. According to recent recommended dietary guidelines published by Indian Council of Medical Research (ICMR-NIN, 2020), dietary fiber provides 2.0 kcal/g.

The protein content of extruded supplementary snack (22.11g per 100g) is significantly higher than that of supplementary-mix (13.12 g per 100 g) since, extrusion process increases the protein digestibility and also reduce the anti-nutritional factors like trypsin inhibitors, that usually impedes the availability of legume proteins (Singh *et al*., 2014). Generally, soy and whey proteins are utilized for enhancing the nutritional quality and structure formation of extruded snacks (Obradović, *et al*., 2014), however these protein sources are not cost effective for inclusion in mass distribution programs like ICDS in low-income countries. Addition of locally available nutrient dense sources like finger millets are always advisable for enhancing the quality of the supplementary foods.

Estimated Dietary Intake (EDI) and percent of Nutrient Contribution (NC)

The estimated dietary intake of each nutrient on a daily basis from the extruded supplementary snack is presented in Table 4. As per the Food Safety and Standards (Advertising and Claims) Regulations, (2018), a product can be claimed as rich source of protein only if it provides not less than 20 per cent of recommended dietary allowances. In this regard, the extruded supplementary snack is a rich protein source, since it provides 25.62 per cent of recommended protein intake per day of children between 4-6 years of age. Compared to control, the extruded snack is a low-fat snack since it provides less than 3 g of fat per 100 grams of the product. Prevalence of overweight (4percent) among children (between 5 -9 yrs. of age) was reported in the latest CNN survey (2018). Occurrence of non-communicable diseases in adulthood is mostly due to predisposition of overweight or obesity in childhood, hence low fat healthy supplementary foods can be introduced to school going children. The optimized extruded snack will be a promising supplementary food for compensating micronutrient deficiency. Hundred grams of extruded supplementary snack provides 127mg of calcium and 1.88 mg of zinc.

The fiber content of the extruded supplementary snack (5.09 g per 100 g) and supplementary-mix (5.47 g per 100 g) are on par and it is evident from previous reported works that extrusion will not affect the total fiber content especially when it is processed at around 22 per cent of moisture, since, low feed moisture increases the specific mechanical energy in the extrusion process (Sharifi *et al*, 2020). Even though, ingredients *viz*., finger millet, whole wheat flour used in the

Table 3: Nutrient composition of the supplementary-mix and extruded supplementary-snack.

Nutrients per 100 g of product	Control~	Extruded supplementary -snack	t value
Energy (kcal)	358.49	355.73	0.80^{NS}
Protein (g)	13.12	22.11	10.87*
Carbohydrate (g)	55.93	60.71	2.27 ^{NS}
Fat (g)	7.92	1.58	20.27*
Fibre (g)	5.47	5.09	1.45 ^{NS}
Calcium (mg)	131.75	127.4	3.04 ^{NS}
Zinc (mg)	1.85	1.88	1*

~ Amrutham nutri-mix developed and distributed through anganwadi centres as part of ICDS scheme.

*Significant at 5 per cent, NS: Non-significant.

Table 4: Estimated daily intake and nutrient contribution.

Nutrients	ED NC	Control	Extruded supplementary snack
Protein (g/day)	ED	3.28	5.52
	NC	25.62	43.12
Carbohydrate (g/day)	ED	13.98	15.17
	NC	13.98	15.17
Fat (g/day)	ED	1.98	0.39
	NC	7.92	1.56
Fibre (g/day)	ED	1.36	1.27
	NC	9.14	8.54
Calcium (mg/day)	ED	32.93	31.85
	NC	7.31	7.07
Zinc (mg/day)	ED	0.46	0.47
	NC	12.43	12.7

extruded snack is rich in insoluble fractions of dietary fiber, it did not affect the expansion ratio, crispness and mouthfeel of the product, because the specific mechanical energy in extrusion process modifies the structural characteristics of dietary fiber wherein the insoluble fractions become soluble (Redgwell *et al*., 2011). Ralet *et al*. (1990) reported that the insoluble fractions of xylose, non-starch glucose and arabinose polymers in wheat bran became soluble on extrusion and author also suggested that this might be due to the mechanical stress the ingredient underwent during extrusion rather than the thermal energy involved in the process.

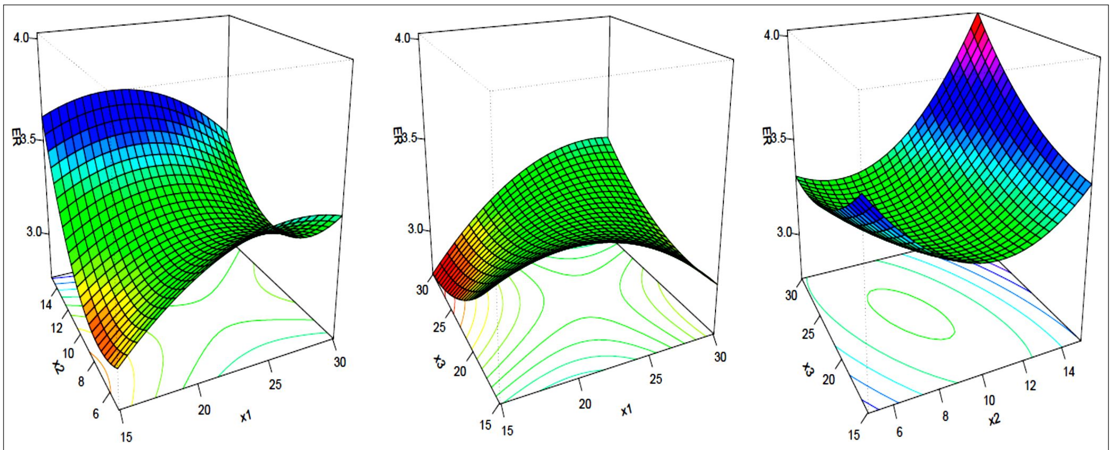
Lack of fiber in children's diet is associated with lot of health problems *viz*., constipation, irritable bowel syndrome and immune related disorders. Recently, the National Academy of Medicine suggested 19 g -25 g of daily intake of dietary fiber per 1000 kcal in children between 3-8 years of age (Stephen *et al*., 2017). The fermentable and bulking fiber from whole wheat and finger millet present in the extrudate will produce SCFAs (short chain fatty acids) which enter into the bloodstream and enhance the immune system by promoting the T cell functioning (Park *et al*., 2015) and improve the anti-inflammatory response (Campos-Perez *et al*., 2021).

Rationale for enriching the extrudates with coconut inflorescence sap honey

The comprehensive national nutritional survey confirms that 18.9 per cent of children in the age group of 1-4 years and 16.8 per cent in the age group of 5-9 years have zinc deficiency in India (MoHFW, 2019). Thus, apart from millets, cereals and tubers the extruded snack also contains coconut sap honey, the rationale for adding coconut sap honey was due to its rich mineral profile. Our own study reveals that the coconut inflorescence sap honey contains calcium (36.98 mg per 100 g), zinc (1.64 mg per 100 g), potassium (3466 mg per100 g), sodium (307.2 mg per 100 g) and magnesium (58.44 mg per 100 g). Likewise, the extruded snack optimized in the present study is also good source of minerals *viz*., calcium (127.4 mg per 100 g) and zinc (1.88 mg per 100 g). Since, pre-schoolers and school going children are at a spurt growth stage, it is necessary to enrich their diet with rich micronutrient sources.

Coconut inflorescence sap being a non-alcoholic, translucent sap obtained from tapping the inflorescence aids in digestion and also acts as a detoxifying agent (Hali, 2013; Muralidharan and Deepthi, 2013). The sugar profile of coconut sap reveals that it is low in total sugars (12.92 per cent) when compared to sugar palm juice (13.42 per cent) and sugarcane juice (15.73 per cent) (Asghar *et al*., 2020). Hence the honey produced from the sap will have lower glycaemic index when compared to sucrose. Thus, we utilized sap honey in our extruded snack to prevent the occurrence of hyperglycaemia. Sap was also found to have anti-inflammatory activity and was observed to downregulate certain inflammatory markers *viz*., lipoxygenase, Prostaglandin E2 and nitric oxide (Ratheesh *et al*., 2017).

Image 1: Coconut inflorescence sap enriched extruded snack developed as part of ICAR TSP.



A. Slice at X3 = 22.61, x1 = 0.359198521385498, x2 = "0.379018295946969

B. Slice at X2 = 8.86, x1 = 0.359198521385498, x3 = 0.0245705506586893

C. Slice at X1 = 24.12, x2 = "0.379018295946969, x3 = 0.0245705506586893

Fig 1: Effect of finger millet, chickpea and corn starch on expansion ratio of the extrudate.

Image 2: Distribution of extruded snacks among the tribal households of Manjeshwar, Karaduka, Parappa blocks of Kasaragod district.

Supplementation of extruded snack

The extruded supplementary snack optimized (Image 1) in this study was supplemented (200 grams packet per individual to 250 households) to the tribal community of Kasaragod district in Kerala, India as part of the ICAR funded Tribal Sub-Plan (TSP) scheme. In a backward district like Kasaragod, the development status of marginalised groups like the Scheduled tribes is more challenging. The major tribal communities in Kasaragod are Mavilan, Malavettuvan, Koraga, Kudiya, Malayarayar, Malaivedan and Ulladan. Of the five particularly vulnerable tribal groups (PVTGs) in the state, Kasargod is home to the ‘Koraga’ tribes which accounts to 3.44 per cent of the tribal population in the district (Census, 2011). As part of the TSP program, when authors had face-to-face interviews with these tribal groups, it was understood that the consumption habit of these groups is skewed and mostly carbohydrate based. This can lead to micronutrient deficiency affecting their quality of life.

In this regard, the extruded supplementary snack was supplemented to the children (4-9 years of age group) and also their family members of this community with the objective to enhance their micronutrient security and entrepreneurial opportunities respectively (Image 2). Since Kasaragod has large stretches of barren land and has previous records of millet cultivation, and currently among the tribals the role of SHGs has been limited to thrift collection and management reducing the scope for women empowerment. It was intended to introduce new products and prospects for value addition of indigenous crops using improved technologies like extrusion among the tribals.

CONCLUSION

The supplementary extrudate developed in this study contributes to 43 per cent of the protein, 15 per cent of carbohydrate, 1.56 per cent of fat, 8.54 per cent of fiber, 7 per cent of Ca and 12 per cent of Zn requirement of children between 4-9 years of age. This snack was preferred over the conventional porridge mixes because of its ready-to-eat nature and its similarity in texture to other preferred snacks. However long-term epidemiological studies are warranted to understand the bioavailability of nutrients from the snack and its impact in counteracting the micronutrient deficiency among the tribal population. The technological know-how of the production of this snack could be handed over to the tribals by training SHGs/clusters and linking them with ICDS and rural livelihood missions to distribute their produce to mid-day meals or anganwadis.

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Conflict of interest: None.

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