European Journal of Nutrition & Food Safety

14(7): 1-12, 2022; Article no.EJNFS.88490
ISSN: 2347-5641

Designing of Ready to Eat Convenient Mid - Day Meal for Children (5-10 yrs) and Adolescents (11-19 yrs) of Sri Lanka Based on Nutritional Perspective

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2022/v14i730511

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/88490

Original Research Article

Received 27 April 2022
Accepted 06 July 2022
Published 13 July 2022

ABSTRACT

The most prevalent malnutrition issues in Sri Lanka are the protein-energy malnutrition (PEM), vitamin A deficiency, and iron deficiency. Childhood and adolescence are the crucial stages of life which mostly susceptible to malnutrition since their major physiological and psychological changes take place. Although a balanced, nutritious diet is essential to them, present socio-economical and higher academic expectations have created a complex environment that often pushes them towards junk foods and unhealthy snacks. The objective of the present study was to develop ready-to-reconstitute convenient mid-day meals in three categories of chicken, fish, and soya, which match to the Sri Lankan local culinary style, with acceptable sensory properties to upgrade the nutritional status of school children (5-10 yrs) and adolescents (11-19 yrs). Those mid-day meals were designed according to the Food-Based Dietary Guidelines (FBDG) of Sri Lanka. The selected ingredients were processed; rice to instant rice, vegetables to dehydrated vegetables, and protein source of chicken, fish, and soya to pre-cooked sterilized curry pouches. The convenient mid-day meal packages were prepared using three portions of instant rice containing 10% of green gram flakes, dehydrated vegetables, and retorted curry mix respectively. Labeling was performed

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according to the type of curry mix inserted into the package as Chicken, Fish, or Soy mid-day meals. Physicochemical and sensorial properties of meals were evaluated. The caloric value of mid-day meals ranged 575 - 640.82 kcal. The protein content of meals ranged from 25.88 g to 32.68g and there was no significant difference (p<0.05) between protein contents in chicken and fish meals**.** The fat contents and dietary fiber contents significantly (p<0.05) differed and the highest contents of fat (3.15 g) and dietary fiber (4.40 g) were observed in **c**hicken meal and soy meal respectively. The mineral contents of tested meals significantly differed (p<0.05) and the significant highest Ca, Fe, K, Fe, and P were observed in soya mid–day meals. The highest mean rank scores for all sensory attributes in terms of odor, appearance, texture, taste, and overall acceptability were observed in the chicken mid-day meal. Ready-to-reconstitute mid-day meals in three categories of chicken, fish, and soya, which could match to the Sri Lankan local culinary style, were developed with acceptable sensory properties.

Keywords: Convenient mid –day meals; ready to eat; children; adolescents; healthy diet.

1. INTRODUCTION

Nutrition has become a major problem for decades in all vulnerable groups in Sri Lanka. Childhood (5-10 yrs) and adolescence (11-19 yrs) are the crucial stages of life, where major physiological and psychological changes take place. Physical and mental development increases the requirement for macronutrients and micronutrients in children and adolescents [1,2]. These needs are influenced by the rapid cell division occurring during growth, which requires protein, energy, and nutrients involved in DNA synthesis and metabolism of protein, calories, and fat. Higher intakes of protein and energy are recommended in the adolescent population since physical growth is accelerated [3].

The deficiencies, excesses, or imbalances in a person's intake of nutrients cause poor physical health, intellectual impairment, delays in reaching milestones, frequent infections/ disabilities, and poor performance at school [3]. Moreover, nutritional problems during early life have a great influence on health in adults [4]. For instance, the increasing prevalence of non-communicable diseases (NCD) such as cardiovascular disease, diabetes, non-alcoholic fatty liver disease, gallstones, kidney diseases, and cancers has become a major issue in the country which is one of the main causes of death. Furthermore, reduced IQ, reduced work capacity, and a higher risk of poor pregnancy outcomes will take place as a result of insufficient nutritional intake at an early age [4].

In Sri Lanka, the most prevalent malnutrition issues are the protein-energy malnutrition (PEM), vitamin A deficiency, iron deficiency, overweight, and obesity [5,6,7]. Prevalence trends of thinness, overweight, and obesity in children and adolescents aged 5–19 years within the period of 2000 to 2016 were gathered in Country Nutrition Profiles Sri Lanka [8]. It showed that overweight and obesity have increased among both girls and boys and predicted further increment. However, thinness showed decreasing trend from 18.4% to 16.6% among boys while increased slightly among girls (12.4%-13.4%). Earlier, the adolescents aged 10 to 15 years showed a high prevalence of underweight (47.2%) and stunting (28.5%) and anemia (11.1%) and a low prevalence of overweight (2.2%), and vitamin A deficiency (0.4%) [9]. Moreover, it was reported that the prevalence of stunting and underweight was significantly higher (p>0.05) among students from rural schools than in urban schools (stunting: 14.8% urban, 30.7% rural; underweight: 35.8% urban, 49.0% rural) and further urban students were overweight than the rural students (5.3% vs. 1.7%). However, the prevalence of anemia among children from rural and urban schools was not significantly different (11.2% and 10.0%) [9].

Since the current lifestyle has basically changed with eating habits, school children are facing many adverse health-related matters led by nutrient-deficient diets. Although maintaining a balanced, nutritious diet is essential, socio-economical and higher academic expectations have created a complex environment that often pushes children and adolescents toward junk foods and unhealthy snacks during school time and after-school activities. Further, teenagers find the freedom to make their own decisions on food and are heavily influenced by their peers. Unfortunately, they consider convenience, attractiveness, and taste and appreciate slim feminine figures, especially in girls rather than

healthiness. To aid this situation, a ready-to-reconstitute nutritional instant meal, which matches the local culinary fashion was developed aiming at school children. The concept of ready-to-eat food i.e. instant food products is a newly developed concept that is the result of modern urbanization.

2. MATERIALS AND METHODS

2.1 Materials

Rice (samba), green gram, and vegetables (carrot, pumpkin, wing beans, and Ambarella) were purchased from the local market. Other food-grade ingredients were purchased from Super Market at Malabe. All the chemicals were purchased from Analytical grade unless otherwise specified.

Enzymes: Alpha-Amylase from Bacillus sp. (*Bacillus licheniformis),*EC 232-560-9, Novozymes A/S, a product of Denmark, Sigma Aldrich.

Pepsin from porcine gastric mucosa, EC 232-629-3, a product of USA, Sigma Aldrich.

Pancreatin from porcine pancreas, EC 232-468-9, a product of USA, Sigma Aldrich.

Standards: Fatty Acid Methyl Esters Standard Mixture: SMB00937, a product of USA, Sigma Aldrich.

2.2 Methods

2.2.1 Designing of mid-day meal

The design of the convenient mid-day meal package was carried out based on the Food-Based Dietary Guidelines published by the Ministry of Health, Sri Lanka as given in Table 1[10]. This publication is designed to provide guidance for an average Sri Lankan on the consumption of a healthy diet in order to specialize in age groups.

According to the FBDG Sri Lanka Table 1[10], the recommended daily servings of cooked rice for a healthy person are 6-11 cups (approximately 1000g) per day. Similarly, the recommended daily servings of cooked vegetables for a healthy person are 9-15 tablespoons (approximately 130 g) per day. Therefore the recommended daily servings per meal consist of cooked rice 300g, cooked vegetables 45g, and protein source 30g.

The ingredients of the mid-day meal should have consisted of the form of instant preparation with sufficient shelf-life expansion. In the present study, it was designed to have consisted of a dry form of instant rice and dehydrated vegetable mix and pre-cooked retorted curry mix (i.e. protein source). Instant rice has been incorporated (10%) with green gram flakes. The amount of instant rice and dehydrated vegetables were evaluated after determining the rehydration ratios.

2.2.2 Preparation of convenient mid-day meal

A convenient mid-day full meal was developed with three types of chicken, fish, and soya. Those meals consisted of three packs of instant rice, dehydrated vegetables, and curry mix.

Portion 1 - Instant rice with green gram flakes pack: A method recommended by a previously reported study [11] was followed for the preparation of instant rice. Rice was washed to remove dust and dirt, and soaked in excess water at ambient temperature for 20 min. Then, the rice was boiled (at a ratio of rice-to-water 1:.3 w/v) for 12 min in order to completely gelatinize the starch. The rice was washed properly with distilled water to avoid lumps and frozen in sealed polyethylene bags at -18°C for 2 h prior to drying in a hot air oven at 60°C until the moisture content was reduced to 8-10% by weight. After returning to room temperature the rice was packaged in polypropylene bags for further use.

Green grams were washed and soaked for 6 h. After draining the water, they were roasted in high flame for 7-10 min until it gave a pleasant odor. Then the grains were flaked using a flaking machine and dried in a hot air oven at 60°C for 4h. The flakes were packaged in polypropylene bags for further use.

Portion 2 -Dehydrated vegetable pack: Cleaned edible vegetables of Pumpkins, Carrots, and Ambarella was washed, cut into appropriate slices, steam blanched for 2 minutes followed by dipping in 1% cold salt (NaCl) solution for 5 minutes. The dice were then dried in a hot air dehydrator at 60 ± 2°C for 8-10 hours until the texture became tough to brittle [12].

Wing beans are cut into thin slices (0.2cm). Then the slices were blanched in hot water with 0.05% magnesium oxide (MgO) for 2.5 min and followed by dipping in 1% cold salt (NaCl) solution for 5 minutes. Then the drained slices

were dehydrated at 60 ± 2°C for 5-6 hours until the texture became crisp. The dehydrated slices were then crushed into smaller particles by hand.

Dehydrated vegetables were mixed in the ratio of 40% carrots, 25% pumpkin, 20% wing beans, and 15% Ambarella after a few trials and sensory tests.

Portion 3- Curry packs: Curry packs (fish, chicken, and soya) were prepared following the Sri Lankan culinary concepts. Among many trials, the curry mixes were chosen on the basis of primary sensory attributes and their physical properties.

Chicken and fish cubes (2.5±2 cm) were marinated in salt and spicy mix for 30 min and stir-fried. 1% salt-containing hot water (95°C) was added to the soya chunks and squeezed off the excess water. As described in food-based dietary guidelines [10], the recommended daily servings of proteins are 90-120g. Therefore, considering per one meal (30±5g) of chicken, fish, and soya chunks were separately filled along with 50±5g of previously prepared gravy into the rotatable pouches. After filling, pouches filled with curries were hermetically sealed using a chamber-type vacuum packaging machine (Model; DZQ 500T/B Vacuum Packer, China). Vacuum sealed pouches were thermally processed with steam–air retort at a Temperature of 121 °C, Pressure 1.5 bar in the pre-determined time period to obtain the desired commercial sterility. Product core temperature during processing was monitored using pair of thermocouples inserted into the core of the product (chicken, fish, or soy chunks) to determine the desired process time. The time required for optimum processing was determined based on the real-time calculated cumulative F_0 value targeting 12D destruction of *Clostridium botulinum* during the thermal processing. Three types of chicken, fish, and soya retorted curry mix pouches were prepared and the commercial sterility of the curry mixes was tested [13].

The convenient mid-day meal packages were prepared using three portions of instant rice containing 10% green gram, dehydrated vegetables, and retorted curry mix. Labeling was performed according to the type of curry mix inserted into the package as Chicken, Fish, or Soy mid-day meals.

2.2.3 Sensory evaluation

A convenient mid-day full meal developed in three types of chicken, fish, and soya was subjected to a sensory evaluation trial to select the most preferable meal. Sensory evaluation trials were conducted by using twelve trained panelists and the samples were evaluated in terms of color, odor, appearance, texture, taste, aftertaste, and overall acceptability using the nine-point hedonic scale. Since a commercially available convenient mid-meal package with Sri Lankan taste is not available in the local market a control sample was not used in the sensory test.

2.2.4 Determination of physical properties of convenient mid-day meal

The instant rice and vegetable pack was tested for rehydration ratio and water activity.

Table 1. Recommended daily servings for children (5-10 yrs) and adolescents (11-19 yrs) in Sri Lanka

Material	Recommended daily servings per day	Recommended daily servings per meal
Cooked rice	6-11 cups (approximately 1000g)	300g
Cooked vegetables	9- 15 table-spoons(approximately 130 g)	45 g
Proteins	90-120g	30-40g

Source; Food-Based Dietary Guidelines 2021, Sri Lanka

Table 2. Summary of the dehydration conditions of vegetable processing

Vegetable	Particle size (cm)	Blanching method	Blanching time (min)	Dehydration time	Final product quality
Carrot	0.5*0.5*0.5	Steam	2	8-10 h	tough to brittle
Pumpkin	0.5*0.5*0.5	Steam	2	8-10 h	tough to brittle
Ambarella	0.5*0.5*0.5	Steam	0	8-10 h	leathery to hard
Wing beans	0.2	Hot water	2.5	5-6 h	crisp

2.2.4.1 Determination of water activity (a_w)

The a_w of the instant rice was determined as operation instructions given in a water activity meter (Model: *Aqua Lab*4TE, USA).

2.2.4.2 Determination of rehydration ratio

A100 mL of water at 95°C were added to 10 g of instant rice samples and kept for 5, 10, and 15 min for rehydration. Excess water was drained away and the samples were weighed. The rehydration ratio was calculated using the following equation [11].

$$ReHydration\ ratio = \frac{WeigHt\ of\ instant\ rice\ after\ absorption\ of\ water\ (g)}{Initial\ dry\ weigHt\ (g)}$$

2.2.5 Determination of chemical properties of convenient Mid - Day Meal

2.2.5.1Proximate composition analysis

The proximate composition of the Mid-Day Meal package was determined according to the AOAC methods [14]: moisture content based on the weight loss after the sample was heated in an oven at 105 °C; ash content by incineration in a muffle furnace at 550 °C; protein content by total nitrogen, using Kjeldahl method, considering conversion factor of % N x 6.25; fat content by Soxtherm method. Total dietary fiber was determined by the enzymatic–gravimetric method [15]. The available carbohydrate content of the samples was calculated by difference (subtracting the summation of moisture, ash, protein, fat, and dietary fiber by a value of 100) [16].

Data were means of triplicates and were expressed as g/100 g.

2.2.5.2 Determination of fatty acid profile

Fatty acids were analyzed as the method described by AOAC 2001 (996.06) [17].

The extracted fat was trans-esterified using 2 mol/L methanolic KOH to form fatty acid methyl esters (FAME). Fatty acids were estimated by GC (Model: 7890B of Agilent Technologies with 7693 Autosampler, equipped with flame ionization detector and split injector).

2.2.5.3 Determination of mineral content

Detection of mineral content was carried out by microwave digestion followed the ICP-MS method of AOAC 2012 (999.10) [14].

2.3 Statistical Analysis

Results were statistically analyzed by using SPSS computer software; SPSS, 2000 [18]. The calculations were carried out by using a one-way analysis of variance ANOVA and significant differences among the various score were established at a 95% confidence level. Mean separation was carried out using the Tukey HSD_{α} test. Sensory analysis of mid-day meals was carried out using Kruskal Wallis Test.

3. RESULTS AND DISCUSSION

3.1 Ready-to-eat Meals

Most of the ready-to-reconstitute foods normally popular among the South-East Asia region are the breakfast meals. They are in dry forms and needed to be reconstituted with milk or water before consumption. There were reported studies on instant breakfast meals [19, 20]. Further a ready-to-reconstitute protein-rich instant poha (beaten rice) – a traditional Indian breakfast was reported using groundnut, moth beans, and seasoning ingredients [21]. Paradhi had reported on the development of instant sprout meal on processes of soaking, germination, dehydration and rehydration [22]. Since most children and adolescents are not obtaining mid-day meals from home due to the complex environment, three types of convenient mid-day meals in Sri Lankan style were designed.

The reported studies on the preparation of mid-day meals were rare and further detailed nutritional quality evaluation was not reported. There was a reported study described five types of ready-to-eat meals, that were prepared using potatoes, potatoes with chicken fillet, potatoes with amaranth, potatoes with quinoa, and potatoes with bulgur using thermal processing (at 120 ± 0.5 C^o for 10 minutes) followed by an evaluation of fiber content, moisture, and hardness [23]. Another research was reported in Bangladesh that the development of an instant food product in powder form (Nutri-mash) from plant sources would be a nutritionally low-cost balanced diet for all the categories of people of the society containing potato, legumes, vegetables, and spices [24].

3.2 Designing of mid-day Meal

Since presently, most children and adolescents are not gaining a proper nutritious mid-day meal,

the designing of the convenient mid-day meal package was carried out based on the Food-Based Dietary Guidelines published by the Ministry of Health, Sri Lanka as given in Table 1[10]. Selection of raw materials was carried out considering the consumer perspectives, nutrient values, local availability, and cost of materials.

The main characteristic of the meal package is all the ingredients were properly pre-processed and reconstituted within 5 min with boiling water except curry mix which could be directly consumed. Curry mix in three forms of chicken, fish, and soya beans was prepared in a way of Sri Lankan culinary fashions and packed in retort pouches followed by retort sterilization technique on the ready-to-serve concept. Those curries could be directly used without any prior preparations.

The dry form of instant rice and dehydrated vegetables were separately packed considering their rehydration ratios as given in Table 2. Instant rice was processed to reconstitute into normal cooked rice within 5 min while reconstitution of dehydrated vegetables was also incompatible to reconstitute in the same time period. The rehydration ratio of instant rice and vegetable mix was determined and the results were given in Table 3.

An instant mid-day full meal was prepared according to the amounts given in Table 4. In considering the rehydration ratio of instant rice (1:3), 100g of instant rice containing 10g of dehydrated green gram flakes were packed in Poly Propylene bags. Similarly considering the rehydration ratio of dehydrated vegetables (1:2), 22.5 g of the vegetable mix was packed in metalized film pouches. A pack of retort pouch containing chicken, fish, or soya chunks (30 ± 5g) and gravy (50 ± 5g) mix was directly included in the mid-day meal package together with instant rice and vegetable pack.

Table 3. Physical properties of instant rice and dehydrated vegetable pack

Component	Moisture	Water Activity (a_w)	Rehydration ratio
Instant rice and flakes mix	6.92 ± 0.26 %	0.3601±0.2	1:3 (w/v)
Dehydrated vegetable pack	10.98 ± 0.51%	0.4365±0.3	1:2 (w/v)

Results were given in mean ± SD of triplicate samples

Table 4. The main portions in the mid-day meal per serving

Component	Weights
Rice and green gram pack	100 g
Curry pack	80 g
Vegetable pack	22.5 g
Water	250 ml (1 cup)
Total weight	**452.5g**

Fig. 1. Ready to Serve Mid-Day Meals with three portions

3.3 Commercial Sterilization of Curry Packs

Since *Clostridium botulinum* is the most critical microorganism in the planning of commercial sterility of thermally processed low acid canned foods, 121.1°C was selected as the reference temperature while z = 10 °C and D = 0.21 minutes for the determination of thermal process time of selected products. The thermal process time required to achieve 12D destruction (F0=2.5 min) of the target microorganism was determined by calculating the cumulative F_0 value every thirty seconds. According to the Commercial sterility of low acid and acid canned foods SLS 516, part 10 [13], those products are commercially sterile where all pathogenic and spoilage organisms including both vegetative and non-vegetative spores that can grow in food under normal storage and handling conditions are destructed.

3.4 Compositional Analysis of Mid-day Meals

3.4.1 Proximate composition

The proximate analysis of mid-day meals of chicken, fish, and soya were presented in Table 5. Moisture contents of mid-day meals (per serving) ranged from 273.44 to 291.63 g. The protein contents of meals ranged from 25.88g to 32.68g and the significantly lowest (p<0.05) protein content was observed in soy mid-day meals. Further, there was no significant difference (p<0.05) between in protein content of chicken mid-day meal and fish mid-day meal**.** The fat contents of mid-day meals were significantly (p<0.05) differed and the highest fat content (3.15 g) was observed in chicken mid-day meals. A significant difference was not observed in ash contents between meals. Dietary fiber contents of meals were significantly (p<0.05) differed and the highest dietary fiber content was observed in soy mid-day meal (4.40 g). It may be due to the curry mix of soya containing plant materials of extruded soya beans and it contributes to the enhancement of dietary fiber content in the meal. Fish and chicken, since they are not coming from plant sources, will not contribute to the dietary fiber. Available carbohydrate contents of the meals were significantly (p<0.05) differed. Among three meals chicken and rice meals showed the highest energy content.

3.4.2 Fatty acid profiles

Fatty acid profiles of mid-day meals in terms of saturated, monounsaturated, and polyunsaturated fatty acids were presented in Table 6. The fatty acid contents of all meals significantly differed and the significant highest saturated, monounsaturated and polyunsaturated fatty acids were observed in chicken mid-day meals. All three meals showed a lesser amount of polyunsaturated fatty acids than mono and saturated fatty acids.

3.4.3 Mineral contents

Mineral contents of mid-day meals in terms of Ca, Mg, Fe, Zn, K, and Na were presented in Table 7.

The mineral contents of all tested meals significantly differed and the significant highest contents of minerals of Ca, Fe, K, and P were observed in the soya mid–day meal. There was no significant difference in Zn contents among the meals while Na content is highest in Fish mid-day meals. In the preparation of curry mix 30 ± 5g of fish or chicken or soaked and drained extruded soya was used as ingredients. Since the moisture content of extruded soya is lesser than fish and chicken, the dry weight of the soy content is high in soya mid-day meals and thereby the mineral content of the soy meal showed higher values than in other meals. Further, the plant source of soya beans contributed to higher mineral content than the fish and chicken meals.

3.5 Sensory Evaluation of Products

Three types of chicken, fish, and soy convenient mid-day meals were evaluated for sensory attributes of odor, appearance, texture, taste, and overall acceptability according to the nine-point hedonic scale. Results of the mean rank scores from the sensory evaluation trial were presented in Table 8 which was further illustrated in the radar chart (Figure 2). It was seen that the chicken mid-day meal had the highest mean rank scores for all sensory attributes while the soy mid-day meal had the lowest mean rank scores. However significant differences (p<0.05) were not observed in each parameter among the meals. All the parameters were not significantly varied with respect to the type of meal. This observation of insignificance of sensory attributes of meals may be due to the flavor attributes given by the gravy of the curry

Table 5. Proximate composition of the mid-day meals

Parameters	Chicken mid-day meal		Fish mid-day meal		Soy mid-day meal	
	Per 100g	Per serving (g)	Per 100g	Per serving (g)	Per 100g	Per serving (g)
Energy (Kcal)	146.47	640.82	131.43	575.00	145.54	636.73
Moisture (g)	63.16±0.21^{a}	276.33	66.66±0.13^{b}	291.63	62.50±0.46^{a}	273.44
Crude Protein (g)	7.47±0.23^{b}	32.68	7.11±0.04^{b}	31.09	5.91±0.17^{a}	25.88
Crude fat (g)	0.72±0.01^{c}	3.15	0.39±0.01^{a}	1.73	0.53±0.05^{b}	2.31
Ash (g)	0.70±0.22^{a}	3.66	0.72±0.13^{a}	3.14	0.77±0.15^{a}	3.36
Dietary fiber (g)	0.65±0.2^{a}	2.86	0.68±0.2^{a}	2.99	1.01±0.2^{b}	4.40
Available Carbohydrates(g)	27.53±0.65^{b}	120.43	24.86±0.46^{a}	108.76	29.28±0.42^{c}	128.11

Values of meals were given in mean ± SD of triplicate samples. Serving size: 452.5g
Values with the same letters are not significantly different

Table 6. Fatty acid profile of meals

Parameters	Chicken mid-day meal		Fish mid-day meal		Soy mid-day meal	
	Per 100g	Per serving	Per 100g	Per serving	Per 100g	Per serving
Saturated fat (g)	0.29±0.00^{c}	1.15	0.16±0.01^{a}	0.64	0.23±0.03^{b}	0.90
Mono unsat. Fat(g)	0.32±0.00^{c}	1.23	0.18±0.00^{a}	0.68	0.22±0.03^{b}	0.85
Poly unsat. Fat (g)	0.09±0.00^{c}	0.38	0.06±0.00^{a}	0.23	0.08±0.00^{b}	0.32

Percentage values of meals were given in mean ± SD of triplicate samples. Serving size: 452.5g
Values with different letters in the raw are significantly different

Table 7. Mineral composition of mid-day meals

Micronutrients	Chicken mid-day meal		Fish mid-day meal		Soy mid-day meal	
	mg/100g	Per serving (mg)	mg/100g	Per serving (mg)	mg/100g	Per serving (mg)
Ca	13.6±0.00^{a}	59.4	11.0±0.00^{a}	48.1	29.75±0.00^{b}	127.75
Mg	12.7±0.00^{a}	55.8	22.7±0.02^{c}	99.4	18.67±0.00^{b}	82.41
Fe	0.5±0.0^{a}	2.4	0.3±0.00^{a}	1.3	1.36±0.00^{b}	6.12
Zn	0.8±0.00^{a}	3.7	0.8±0.00^{a}	3.3	0.84±0.00^{a}	3.71
K	101.5±0.20^{b}	444.0	91.9±0.20^{a}	401.9	139.84±0.00^{c}	609.665
Na	45.1±0.10^{b}	197.4	74.8±0.10^{c}	327.4	27.96±0.00^{a}	122.629
P	59.2±0.20^{b}	259.2	44.4±0.00^{a}	194.1	76.53±0.00^{c}	334.82

Percentage values of meals were given in mean ± SD of triplicate samples. Serving size: 452.5g
Values with the same letters are not significantly different

Table 8. Mean rank scores for the convenient mid-day meals

Type of meal	Appearance	Colour	Texture of Rice	Texture of Chunks	Odor	Taste	Overall Acceptance
Chicken	10.67	10.67	10.25	11.00	10.50	11.25	12.67
Fish	10.25	9.25	9.42	9.00	8.08	9.50	8.67
Soy	7.58	8.58	8.83	8.50	9.92	7.75	7.17

Table 9. Comparison of mid-day meals with Recommended Dietary Allowances (RDA)

	Energy (kCal)	Protein (g)	Calcium (mg)	Iron (mg)	Zinc (mg)	Magnesium (mg)
AVG RDA*	1963	42	850	19	7	163
AVG RDA**	2788	67	1000	36	8	225
Chicken mid-day meal	640.82	32.68	59.4	2.4	3.7	55.8
Fish mid-day meal	575.00	31.10	48.1	1.3	3.3	99.4
Soya mid-day meal	636.73	25.88	127.75	6.12	3.71	82.41

**Recommended Dietary Allowances for Sri Lankan children at age of 6-11 Yrs (RDA, 2007)*

***Recommended Dietary Allowances for Sri Lankan Adolescents at age of 12-18 Yrs (RDA, 2007)*

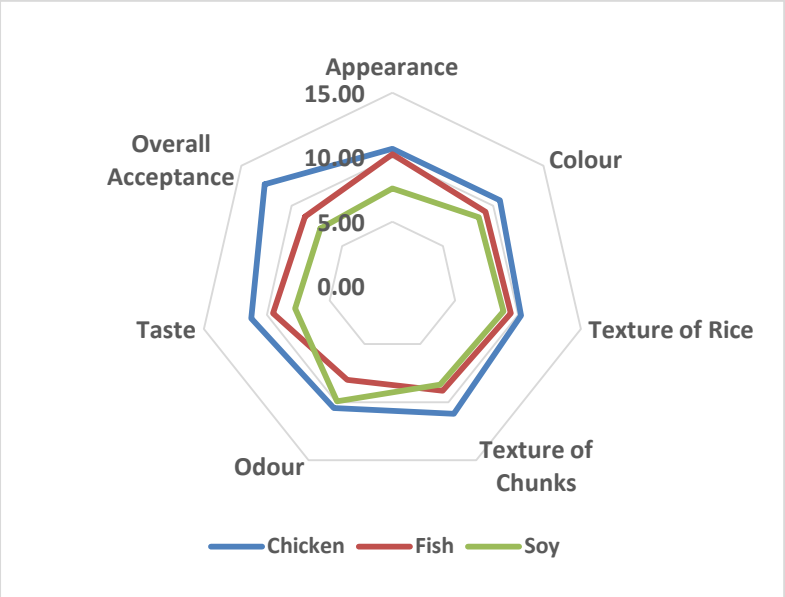

Fig. 2. Radar chart of variations of sensory attributes of three types of mid-day meals

mix where it was the same formula to all the meals. Meals give the characteristic flavor and taste with respect to the gravy.

3.6 Comparison of Mid-day Meals with Recommended Dietary Allowances (RDA) for Sri Lankan Children and Adolescents

According to the data published by the Department of Nutrition, Medical Research Institute, Colombo in 2007, the average values of Recommended Dietary Allowances (RDA) for Sri Lankan children at the age of 6-11 yrs and adolescents at the age of 12-18 yrs were presented in Table 9 [25]. Further, the mean values obtained from the composition analysis of protein, calcium, iron, zinc, and magnesium in prepared mid-day meals were presented in Table 9.

In considering the caloric values of the three types of meals, it was ranging from 575.00 - 640.82 Kcal and those meals provide approx. 1/3 of energy contributes to the RDA for children (1963 kcal) while approximately 1/4 -1/5 of energy contributes to the RDA value for adolescents (2788 kcal). Energy contribution to RDA from chicken mid-day meal is higher than other meals. More than half of the protein requirement for RDA for children (42 g) will be fulfilled by all three meals while less than half of the protein requirement for RDA for adolescents (67 g) will be fulfilled by all meals.

The highest contributions to the RDA value for calcium, iron, and zinc will be contributed by the soya mid-day meal. The contribution of calcium to the RDA will be approx. 1/6 for children while and 1/8 for adolescents respectively from soya meal. As well as the contribution of iron to the RDA value made by soy meal will be 1/3 and 1/6 for children and adolescents respectively. Chicken, fish, and soy meals were shown the same zinc contents, and contributions made were in similar portions. Results further showed that soy and fish meals were contributing more or less similar contributions to RDA value for manganese while chicken meals contributed less value.

4. CONCLUSION

In the present study, the ready-to-reconstitute instant mid-day meals in three categories of chicken, fish, and soya, which match the Sri Lankan local culinary style, were developed with acceptable sensory properties. Those mid-day meals were designed according to the Food-Based Dietary Guidelines (FBDG) of Sri Lanka, with special guidance for children (5-10 yrs) and adolescents (11-19 yrs). The highest mean rank scores for all sensory attributes in terms of odor, appearance, texture, taste, and overall acceptability were observed in the chicken mid-day meal. The caloric value of mid-day meals ranged from 575 - 640.82 kcal and those meals will be provided approx. 1/3 of energy contributes to the RDA for children while

approximately 1/4 -1/5 of energy contributes to the RDA value for adolescents. Protein contents of meals ranged from 25.88 g to 32.68 g and no significant difference (p<0.05) was observed between protein contents in chicken and fish meals**.** More than half of the protein requirement to RDA for children will be fulfilled while less than half of the protein requirement to RDA for adolescents will be fulfilled by all three meals. The fat contents and dietary fiber contents significantly (p<0.05) differed and the highest contents of fat (3.15 g) and dietary fiber (4.40 g) were observed in chicken meal and soy meal respectively. The mineral contents of tested meals significantly differed (p<0.05) and the significant highest Ca, Fe, K, Fe, and P were observed in soya mid-day meals. The highest mineral contributions to the RDA value for calcium, iron, and zinc will be contributed by the soya mid-day meal.

ACKNOWLEDGEMENT

The authors acknowledged the National Research Council (NRC) of Sri Lanka, for granting financial support to the study (Grant Number: NRC 19-007).

COMPETING INTEREST

Authors have declared that no competing interests exist.

REFERENCES

1. Savarino G, Corsello A, Corsello G. Macronutrient balance and micronutrient amounts through growth and development. Ital J Pediatr. 2021;47 (1):1-14.
2. Kasunmala IGG, Wickramasinghe I, Theja Herath. Food as Nutritional Source to prevent Malnutrition among Developing Countries. In; Paul PK, Mahawar MK, Arghya M, Abobatta W, Payel P, editors. Trends and Prospects in Technology, Processing and Preservation. Today and Tomorrow's Printers and Publishers, New Delhi, India. 2018;457-479.
3. Lassi Z, Moin A, Bhutta Z. Nutrition in Middle Childhood and Adolescence in Child and Adolescent Health and Development. Bundy DAP, Silva Nd, Horton S, editors. 3rd edition. Washington (DC); 2017.
4. Sweeny K. The influence of childhood circumstances on adult health. Commissioned report No. 01. Victoria Institute of Strategic Economic Studies, Victoria University, 300 Queen Street, Melbourne, Victoria; 2014.
5. Jayawardena PA. Proactive Path to Combat Malnutrition in Sri Lanka. Health and Education Research Series No.16. Institute of Policy Studies of Sri Lanka; 2020 (ISBN 978-955-7397-19-1).
6. Jayatissa R, Hossaine SMM. Nutrition and Food Security Assessment in Sri Lanka. Medical Research Institute. Sri Lanka; 2010.
7. Jayatissa R, Gunathilaka MM, Fernando DN. National nutrition and micronutrient survey. Part I: Anaemia among children aged 6-59 months and nutritional status of children and adults. Nutrition Landscape Information System (NLiS), Colombo, Sri Lanka; 2013.
8. Global Nutrition Report. Development Initiatives. Creative Commons Attribution BY-NC-ND 4.0; 2021.
   Accessed 09th Feb 2022.
   Available:https://globalnutritionreport.org/reports/2021-global-nutrition-report.
9. Jayatissa R, Ranbanda RM. Prevalence of challenging nutritional problems among adolescents in Sri Lanka. Food Nutr Bull. 2006;27(2):153-160.
10. Nutrition Division of Ministry of Health. Food Based Dietary Guidelines for Sri Lankans. Colombo, Sri Lanka; 2021.
11. Prapluettrakul B, Tungtrakul P, Panyachan S, Limsuwan T. Development of instant rice for young children. Silpakorn U Sci Tech J. 2012;6(1):49-58.
12. Dipersioa PA, Kendalla PA, Yoonb Y, Sofos JN. Influence of modified blanching treatments on inactivation of Salmonella during drying and storage of carrot slices. Food Microbiol. 2007;24:500–507.
13. Sri Lanka Standards. Microbiological Test Methods, Methods of test for microbiology of food and animal feeding stuffs - Commercial sterility of low acid and acid canned foods SLS 516: Part 10, Sri Lanka Standards Institution, Colombo, Sri Lanka; 1983.
14. AOAC Official methods of analysis, Association of Official Analytical Chemists. 19th ed. Gaithersburg, MD. USA; 2012.
15. Asp NG, Johansson CG, Hallmer H, Silijestrom M. Rapid enzymatic assay of insoluble and soluble dietary fiber. J. Agric. Food Chem. 1983;31:476 - 482.

16. Matela KS, Pillai MK, Matebesi-Ranthimo P, Ntakatsane M. Analysis of Proximate Compositions and Physiochemical Properties of Some Yoghurt Samples from Maseru, Lesotho. J. Food Nutr. Res. 2019; *2*(3):245-252.
17. AOAC Official Methods of Analysis, Association of Official Analytical Chemists. 17th ed., Gaithersburg, MD, USA; 2001.
18. IBM SPSS Statistics for Macintosh, Version 20; 2000.
19. Ransumithila C, Saravanakumar R. Development of value added millet based nutritious Instant Dhokla Mix. Int. j. chem. stud. 2019;7(3):4878-4882.
20. Islam M, Sarker MNI, Islam MS, Prabakusuma AS, Mahmud N, Fang Y, Yu P, Xia W. Development and Quality Analysis of Protein Enriched Instant Soup Mix. Food and Nutr Sci. 2018;9:663-675.
21. Wadikar DD, Divya V, Patki PE1. Studies on Development of High ProteinInstant Poha (Beaten Rice) - A Traditional Indian Breakfast. Ann Food Sci Nutr. 2016;1(1): 35-42.
22. Paradhi A, Patil K, Dagadkhair A, Andhale R. Screening of Grains for Development of Instant Sprouts Meal as a Convenience Food and its Quality Evaluation. Proceeding of MIT School of Food Technology, India; 2020.
23. Muizniece-Brasava S, Ruzaike A, Gramatina I. Development of a Ready to Eat meals with high nutrient value. J Intl Sci Pub. 2016;4:1-7.
24. Huq AKO, Rashid DR, Zubair MA, Rahman AKM, Rahman MM. Studies on the development of an instant Food product (NUTRI-MASH) from plants sources and its clinical effects on health. J. Socio. Res. Dev. 2008;5(3):291-294.
25. Ministry of Health. Food Act, No.26 of 1980. The Gazette –EXTRA ORDINARY of the Democratic Socialist Republic of Sri Lanka; 2005.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/88490