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Physico-chemical evaluation of selected ingredients for preparation of instant Appe mix

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Abstract
The present study was carried out to evaluate the physico-chemical properties of selected ingredients i.e. Rice, Black gram dal, Finger millet and Foxtail millet for the formulation of instant appe mix. Physical properties such as length, width, thickness, bulk density, true density, thousand kernel weight, porosity and angle of repose were evaluated. Chemical/proximate composition of the selected ingredients was analyzed for the parameters such as moisture, protein, fat, carbohydrate, crude fiber and ash, obtained result shows that rice contains high amount of carbohydrate (72.5±0.5%) and black gram dal was good source of protein (22.43±0.1%). Finger millet and foxtail millet were found to be having good nutritional profile with respect to protein, carbohydrate and crude fiber. Finger millet contains high amount of calcium with the value 336.6±0.152mg/100g. The selected ingredients found to be good in nutritional content and will help to enhance the health beneficial properties.

Keywords: Physico-chemical, finger millet, foxtail millet, proximate, nutritional

Introduction
Appe is a traditional cereal/legume based food product. Appe is one of the fermented product which is preferred for the breakfast. It is type of pancake originated in south India. It is a well-known breakfast food in south India with spongy texture, attractive appearance, appetizing taste and flavor. It is easy to digest with good nutritive value which contributing to its increasing popularity in all parts of India. Appe is prepared using ingredients such as rice, black gram, Bengal gram, green gram, red gram and lentil. In the present investigation the attempts have been made to formulate the appe using rice, black gram dal, finger millet and foxtail millet.

Rice (*Oryza sativa* L.) is one of the most important staple food crop (Palanivel *et al*., 2016) [15]. India ranks second in the production of rice after China with the production of 155.682 million metric tons per annum. West Bengal, Punjab, Uttar Pradesh, Andhra Pradesh, Tamil Nadu and Bihar are the top rice producer states of India. Rice is a gluten free cereal. It is rich source of carbohydrate and contains 75-80% starch. Rice is low-fat complex carbohydrate that is immediately digested and rapidly made accessible to the muscles and other body parts and acts as ideal source of energy. It is good source of protein and contains all 8 essential amino acids, necessary for building blocks for strong muscles. Rice contains 6.75% protein, 0.14% fat, 0.28% ash, 81.80% carbohydrate and 0.80% fiber.

Black gram (*Vigna mungo* L.) originated in India. India is the world's largest producer as well as consumer of black gram. It produces about 1.5 to 1.9 million tons of black gram (urad) annually from about 3.5 million hectares of area, with an average productivity of 500 kg per hectare. Black gram output accounts for about 10% of India's total pulse production. In India Maharashtra, Uttar Pradesh, Andhra Pradesh, Orissa, Tamil Nadu, Rajasthan, Chhattisgarh and Madhya Pradesh are the top cultivators and producer of black gram. It is part of diet for millions of people and a cheap source of protein with 17-34% of protein in Seeds (Gour, 1993) [8]. Black gram is perfect combination of all nutrients, which includes proteins (23%), carbohydrates (51%), fat (1.7%), ash (3.17%), zinc (3.00mg), iron (5.97mg) and calcium (55.64mg). Black gram has a mucilaginous material which makes it a valuable ingredient in fermented products like dosa and idli preparation.

Millets are small-seeded cereals with excellent nutritional quality (Wandhekar *et al*., 2021) [26]. Millet is one of the staple food for human beings as it is highly nutritious and non-glutinous. Minor millets play an important role in the food and nutritional security for poor family people. Due to its good nutritional profile it is recommended in the diet of pregnant women,

nursing mothers, children and the elderly. The most popular millet produced in India are pearl millet/spiked millet (Bajra), finger millet (Ragi), great millet/sorghum (Jowar), foxtail millet (Kheri), little millet (Samai) and barnyard millet (Jhungori) (Ahmed *et al*., 2013) [1].

Finger millet (*Eleusine coracana* L.) is also known as ragi (Wandhekar *et al*., 2020) [25] India is largest producer of finger millet and contributes 60% of global production (Kamini and Sarita, 2011) [12]. In India Karnataka, Tamil Nadu, Andhra Pradesh and parts of North India are the top producers of finger millet (Vijayakumari *et al*., 2003) [24]. Finger millet contains the lowest fat and rich source of calcium. Finger millet per 100g contains carbohydrates (65–75g), dietary fiber (18g), protein (6–13g), minerals (2.5–3.5g) and calcium (0.38g) (Devi *et al*., 2014) [6]. Finger millet helps in strengthening bone and reduces risk of bone damage as good in calcium content. It is Good source of sulphur containing amino acids like tryptophan, cystine and methionine. Naturally iron is present in finger millet helps to cure anaemia. Finger millet helps to increase the haemoglobin level in blood.

Foxtail millet (*Setaria italica*) is one of the oldest cultivated millets in the world. Foxtail millet is also known as Italian millet. In the countries of Asia, Africa and America it is mostly cultivated. Foxtail millet is second most cultivated millet after pearl millet and grown in hot drought and semiarid zones. Karnataka, Telangana, Andhra Pradesh, Maharashtra, Tamil Nadu, Rajasthan and Uttar Pradesh are the top producers of finger millet in India. Nutritional profile of foxtail millet per 100g shows, carbohydrate (60.9g), protein (12.3g), fat (4.3g), crude fiber (8.0g), mineral (3.3g) and the energy value (351kcal) (Sharma and Keshavan, 2017) [19]. It is also good source of minerals including magnesium, manganese and phosphorus. Foxtail millet is richest source of fiber among the all millets (Hariprasanna, 2016) [10]. Foxtail millet is good food for the heart as it contain high amount of magnesium. Foxtail millet seeds increase kidney functionality, helps in development of body tissue and energy metabolism.

In the present study the physical and chemical parameters of the selected ingredients such as rice, black gram dal, finger millet and foxtail millet evaluated for the standardisation and preparation of Instant appe mix with the utilization of cereal, pulse and millets based on their quality to achieve the desirable objectives.

Materials and methodology

The present research study was carried out in Department of Food Engineering with collaboration of Department of Food Chemistry and Nutrition in College of Food Technology, VNMKV, Parbhani during year 2020-21.

Materials

The raw material required during the research work such as Rice (*Oryza sativa* L.), Black gram (*Vigna mungo* L.), Finger millet (*Eleusine coracana* L.) and Foxtail millet (*Setaria italica*) were purchased from the Aakar super shop, Parbhani, Maharashtra. The chemicals and reagents used for analysis were of analytical grade. All chemicals and glass wares required during research work were obtained from the department of Food Chemistry and Nutrition College of Food Technology, VNMKV, Parbhani and used at the time of research work.

Methods

Physical properties of selected ingredients

Average length, width and thickness of ingredients were measured using Vernier caliper as per the process given by (Pawase *et al*., 2019) [16]. Thousand kernel weight of sample was analyzed by weighing the thousand kernels on weighing balance. Bulk density, true density and porosity were measured as per the methods given by (Bagheri *et al*., 2011) [5]. Angle of repose was calculated by the formula and method given by (Mohsenin, 1986) [14].

Proximate analysis

All four selected samples were crushed using mortar and pestle and converted into powder form. Then the samples were analyzed for moisture, protein, fat, total ash, crude fiber and total carbohydrate contents according to their respective standard methods as described in (AOAC, 2000) [4].

Mineral Analysis

Five grams of each sample was weighed in crucible and burn it on heating plate till the sample becomes fumeless. The obtained sample was placed in muffle furnace at 550°C for 5-6 hrs. The obtained ash samples were digested with concentrated Hydrochloric acid (HCL) on hot plate. The digested material was then filtered using whatman No. 42 filter paper and the final volume made to 100ml with distilled water the obtained mineral solution was further used for analysis with respect to minerals Calcium, Magnesium, Phosphorus, Zinc, Iron and Copper content by using methods given by Ranganna (1986) [18].

Results and discussion

Physical properties of rice and black gram dal

Different physical properties such as length, width, thickness, bulk density, true density, thousand kernel weight, porosity and angle of repose for the rice and black gram dal were evaluated and the obtained data of results are summarised in Table no. 01.

Table 1: Physical properties of rice and black gram dal

Parameters	*Values	
	Rice	Black gram dal
Length (mm)	7.12 ± 0.009	4.85 ± 0.05
Width (mm)	2.03 ± 0.008	3.2 ± 0.01
Thickness (mm)	2.15 ± 0.004	3.05 ± 0.01
Bulk density($Kg.m^{-3}$)	710.6 ± 1.69	814 ± 1
True density ($Kg.m^{-3}$)	1329.6 ± 1.24	1346 ± 1.52
Thousand kernel weight(g)	30.06 ± 0.01	49.61 ± 0.01
Porosity (%)	46.53 ± 0.16	39.55 ± 0.08
Angle of repose (°)	34 ± 0.08	27.51 ± 01

*Each value represents the average of three determinations

Data from the table no. 01 showed that average length, width and thickness of rice were 7.12± 0.009, 2.03± 0.008 and 2.15± 0.004 mm respectively where as for the black gram 4.85± 0.05, 3.2 ± 0.01 and 3.05± 0.01mm respectively. (Ghadge and Prasad, 2012) [7] reported the similar results for physical properties of rice for its length, width and thickness. Average bulk density and true density of rice and black gram dal were 710.6± 1.69, 1329.6± 1.24 and 814± 1, 1346± 1.52 $Kg.m^{-3}$ respectively. Average thousand kernel weight of rice and black gram was 30.06± 0.01 and 49.61± 0.01 g respectively % Porosity for rice and black gram was observed 46.53± 0.16 and 39.55± 0.08. Angle of repose helps in

designing the hopper of mill and in filling machine. Angle of repose in degree for rice was 34± 0.08 which was found to be similar with the result reported by (Varnamkhasti *et al*., 2008) [22] and for black gram it was 27.51± 01. The obtained results of black gram dal for bulk density, true density and angle of repose was found to be similar with the data obtained by (Sharon *et. al*., 2015) [20].

Physical properties of finger millet and foxtail millet

Physical properties like length, width, thickness, geometric mean diameter, bulk density, true density, thousand kernel weight, porosity and angle of repose were evaluated for finger millet and foxtail millet and obtained results are represented in Table no 02.

Table 2: Physical properties of finger millet and foxtail millet

Parameters	*Values	
	Finger millet	Foxtail millet
Length (mm)	1.67 ± 0.02	2 ± 0.09
Width (mm)	1.44 ± 0.01	1.49 ± 0.01
Thickness (mm)	1.35 ± 0.01	1.45 ± 0.02
Geometric mean diameter (mm)	1.48 ± 0.01	1.62 ± 0.03
Bulk density ($Kg.m^{-3}$)	781 ±1.0	722.33 ± 1.52
True density ($Kg.m^{-3}$)	1277 ±1.0	1260.66 ± 1.52
Thousand kernel weight (g)	2.75 ±0.13	2.65 ± 0.05
Porosity (%)	38.83 ±0.06	42.69 ± 0.14
Angle of repose (°)	29.26 ±0.38	26.72 ± 0.01

*Each value represents the average of three determinations

Data obtained from table no. 2 showed that the average length, width and thickness of finger millet was 1.67±0.02, 1.44±0.01 and 1.35±0.01 mm and for foxtail millet it was 2±0.09, 1.49±0.01 and 1.45±0.02mm respectively. The average geometric mean diameter for finger millet and foxtail millet was 1.48±0.01 and 1.62±0.03 mm respectively. Similar findings for these physical properties of the finger millet was observed by (Pawase *et al*., 2019) [16]. Average bulk density and true density of finger millet was 781±1.0 and 1277±1.0 $Kg.m^{-3}$ whereas for foxtail millet it was 722.33± 1.52 and 1260.66± 1.52 $Kg.m^{-3}$ respectively. The results of bulk density, true density and porosity of finger millet agree with the findings (Powar *et al*., 2018) [17]. Thousand kernel weight of finger millet and foxtail millet observed was 2.75±0.13 and 2.65± 0.05 g. Average porosity in % for finger millet and foxtail millet was 38.83±0.06 and 42.69±0.14. Angle of repose in degree for the finger millet and foxtail millet was 29.26±0.38 and 26.72±0.01 respectively. The results obtained for the physical properties of foxtail millet agree with the findings of (Sunil *et al*., 2016) [21].

Proximate composition of rice and black gram dal

The chemical parameters like moisture content, protein, fat, carbohydrate, crude fiber and ash content for the rice and black gram were analysed and obtained results are represented in the table no. 03 as below.

Table 3: proximate composition of rice and black gram dal

Parameters	*Values	
	Rice	Black gram dal
Moistre (%)	10.53±0.03	11.17±0.28
Protein (%)	9.11±0.03	22.43±0.15
Fat (%)	1.08±0.01	1.41±0.01
Carbohydrate (%)	72.5±0.5	56.25±0.57
Crude fiber (%)	1.42±0.03	3.69±0.10
Ash (%)	1.3±0.01	2.86±0.03

*Each value represents the average of three determinations

The obtained result from the table 3 showed that the moisture content for the rice and black gram dal was 10.53±0.03 and 11.17±0.28 (%) respectively. Black gram dal contains the higher protein 22.43±0.15 (%) whereas the rice contians 9.11±0.03 (%). Fat content was observed very less in both the ingredients it was 1.08±0.01 and 1.41±0.01 (%) in rice and black gram. Rice was found to be good source of carbohydrate with 72.5±0.5 (%). Carbohdrate content in black gram was found to be 56.25±0.57 (%). The results of proximate composition of rice with respect to moisture, protein, fat and carbohydrate agree with the (Verma and Srivastav, 2017) [23]. Crude fiber of rice and black gram was 1.42±0.03 and 3.69±0.10 (%) respectively. Mineral content of the ingredients is depend on the ash content and (%) ash was observed in rice and black gram was 1.3±0.01 and 2.86±0.03 respectively. Protein, Fat and Carbohydrate of black gram dal was found to be similar with the research findings of (Anjali and Rani V., 2018) [2].

Chemical composition of Finger millet and Foxtail millet

The chemical parameters like moisture content, protein, fat, carbohydrate, crude fiber and ash content for the finger millet and foxtail millet were estimated and obtained results are summerised in the table no. 04 as below.

Table 4: Chemical composition of finger millet and foxtail millet

Parameters	*Values	
	Finger millet	Foxtail millet
Moistre (%)	9.51±0.40	9.11±0.03
Protein (%)	7.06±0.15	12.22±0.19
Fat (%)	1.18±0.1	4.3±0.3
Carbohydrate (%)	69.73±0.56	60.05±0.2
Crude fiber (%)	3.17±0.02	7.5±0.1
Ash (%)	2.13±0.15	2.69±0.1

*Each value represents the average of three determinations

From table no. 04 the study revealed that the moisture content of the finger millet and foxtail millet was 9.51±0.40 and 9.11±0.03 (%) respectively. Protein content of the foxtail millet was found to be higher than the finger millet. Protein content in the finger millet and foxtail millet was found to be 7.06±0.15 and 12.22±0.19 (%). The value of protein content agree with the result obtained by (Gull *et al*., 2014) [9]. Fat content of finger millet was 1.18±0.1 (%). Where as fat content of foxtail millet was 4.3±0.3 (%) which is similar with the values obtained by (Hariprasanna, 2016) [10]. Both millets were found to be good source of Carbohydrate with the values 69.73±0.56 and 60.05±0.2 (%) respectively and found to be potential source of energy (Sharma and Niranjan, 2017) [19]. Crude fiber content in the foxtail millet was more than the finger millet which was found to be helpful for gut health (Issoufou *et al*., 2013) [11]. The values obtained after analysis was found to be 3.17±0.02 and 7.5±0.1 (%) respectively. Ash content of the finger millet and foxtail millet was 2.13±0.15 and 2.69±0.1 (%) respectively.

Mineral composition of rice and black gram dal

The minerals like calcium (Ca), magnesim (Mg), phosphorus (P), zinc (Zn), iron (Fe) and copper (Cu) were estimated and the results are presented in the Table no. 05.

Table 5: Mineral composition of rice and black gram dal

Parameters	Values (mg/100g)	
	Rice	Black gram dal
Calcium	11.33±1.52	126.6±152
Magnesium	28.06±1	255.2±1.05
Phosphorus	134.33±1.52	311±1
Zinc	3.33±0.20	3.13±0.01
Iron	0.8±0.1	7.05±0.02
Copper	0.31±0.01	0.96±0.01

*Each value represents the average of three determinations

The result obtained was found to be, mineral content of rice with respect to calcium (11.33±1.52), magnesim (28.06±1), phosphorus (134.33±1.52), zinc (3.33±0.20), iron (0.8±0.1) and copper (0.31±0.01) mg/100g respectively. Mineral composition of rice was found to be similar with the results narrated by (Anjum *et al*., 2007) [3]. Mineral composition of black gram dal was calcium (126.6±152), magnesim (255.2±1.05), phosphorus (311±1), zinc (3.13±0.01), iron (7.05±0.02) and copper (0.96±0.01) mg/100g respectively. The results of mineral analysis for the black gram was agree with the (Modgil *et al*., 2019) [13].

Mineral composition of finger millet and foxtail millet

The minerals like calcium (Ca), magnesim (Mg), phosphorus (P), zinc (Zn), iron (Fe) and copper (Cu) were estimated for finger millet and foxtail millet and the results are presented in the Table no. 06.

Table 6: Mineral composition of finger millet and foxtail millet

Parameters	Values (mg/100g)	
	Finger millet	Foxtail millet
Calcium	336.6±0.152	28.2±0.72
Magnesium	132±1	75.16±1.04
Phosphorus	263.8±1.25	273±1
Zinc	1.8±0.1	2.1±0.1
Iron	3.56±0.15	2.54±0.05
Copper	0.37±0.02	1.29±0.04

*Each value represents the average of three determinations

Mineral composition of finger millet was calcium (336.6±0.152), magnesium (132±1), phosphorus (263.8±1.25), zinc (1.8±0.1), iron (3.56±0.15) and copper (0.37±0.02)mg/100 g respectively where as mineral composition of foxtsil millet was calcium (28.2±0.72), magnesium (75.16±1.04), phosphorus (273±1), zinc (2.1±0.1), iron (2.54±0.05) and copper (1.29±0.04)mg/100 g respectively. The obtained result for the mineral content of finger millet found to be similar with (Gull *et al*., 2014) [9]. Mineral composition of foxtail millet was agree with the result obtained by (Hariprasanna, 2016) [10].

Conclusion

The physical properties were used in determining the machine, operation and process efficiency while studying the unit operations. During designing the equipment for operations like processing, sorting and sizing physical properties plays an important role. Rice was found to be good source of energy with carbohydrate content of 72.5±0.5 (%). Black gram was a good source of protein with value 22.43±0.15 (%). Both the finger millet and foxtail millet was found to be good in nutrition with the higer values of carbohydrate content 69.73±0.56 and 60.05±0.2 (%) respectively. Crude fiber content of foxtail millet was 7.5±0.1(%). Finger millet cotains the highest amount of calcium 336.6±0.152mg/100g. Overall it can be concluded that the selected ingredients for the preparation of instant appe mix having the good nutritional profile. This study shows that the utilization of millet for the formulation of different food products will achieve an great success with its nutrional and health importance.

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