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Physio-chemical and sensory analysis of noodles fortified with cowpea and pomegranate peel powder

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Abstract
Noodles gain popularity due to its low glycemic index (GI) and ready to eat convenience. Effects of fortification on noodles with the combination of dehulled cowpea flour and pomegranate peel powder were studied. Nutritional, cooking and sensory qualities of noodles were analyzed. The fortification of whole wheat flour noodles was done by the combinations of cowpea flour and pomegranate peel powder (5% and 10%) and (5% and 7%) respectively. The results showed that, increase in whole wheat flour proportion increases cooking loss. The resultant product is found to be highly nutritious because of its fibers, phenolic compounds, antioxidants and proteins. Sensory and cooking quality results showed that, noodles containing 10% dehulled cowpea flour and 7% pomegranate peel powder was more acceptable.

Keywords: noodles, cowpea, pomegranate peel, fortification, cooking quality

Introduction
In today's world health, nutrition and convenience are the three major factors essential for development of breakfast snack and other variety of products. One of the great challenges for today's food industry is to develop inexpensive foods which are nutritionally rich and should contain all essential nutrients which are required for human health. Pasta, whether it is in the form of noodles, macaroni or spaghetti, it is consumed worldwide (Baskaran *et al.*, 2011) [4]. It is also economical, very easy for preparation, longer shelf life and can be prepared in different varieties. It is acceptable for consumption among people of all socioeconomic and age groups. Noodles and other type of pasta are rich source of carbohydrates but they are deficient in other essential nutrients. While preparation of semolina, bran and germ of wheat grain is removed and only the endosperm of wheat grain is used which lacks nutrients such as vitamins and minerals. Hence in the present study whole wheat flour is used instead of semolina and fortified with dehulled cowpea (*Vigna unguiculata*) flour and pomegranate (*Punica granatum*) peel powder for enhancing the nutritional value and make noodles as a complete protein source by balancing the indispensable and dispensable amino acids such as lysine, tryptophan and threonine.

Wheat or bread wheat (*Triticum aestivum*) is mostly cultivated in the world. Wheat is a major source of dietary energy and protein for people whom daily diet is composed of cereal products. It is the world's most important crop in terms of production and consumption. More than 60% of the total daily requirements of protein and calories are met through wheat (Zuzana *et al.*, 2009) [15] and it is cheapest source of protein and calories in the diet (Eman *et al*., 2012) [7].

Legumes contain relatively high amount of protein than other plant foodstuffs. Legume proteins are mainly used in food formulations to complement the protein in cereal grains because of their chemical and nutritional characteristics. Being in the class of legume, they are often referred to as "poor man's meat" owning to their use as primary protein sources. They represent one of the dietary staples in many parts of the world. Cowpea is of considerable importance in Nigeria and in many African countries as a nutritious leguminous crop providing an alternative source to animal protein (Khalid and Iharadallou, 2014) [8]. Cowpeas, like most other grain legume, contain anti nutritional factors (ANF's) such as trypsin inhibitors, lectins and tannins, which decrease protein digestibility and reduce protein quality (Khalid and Iharadallou, 2014; Nielsen and Sumner, 1980; Nell and Siebrits, 1992) [8, 9, 10]. So that while preparation of cowpea flour, hull (seed coat) is removed to eliminate the anti-nutritional factors which results in better digestion and it also helps to improve the appearance

of the flour, because the seed coat has the black colored eye spot on it.

Pomegranate (*Punica grantum*) is very popular for its functional and nutritional properties which can be used as the pharmaceutical agent such as antimicrobial, antiviral, anticancer, antioxidant and antimutagenic activities (Ahmed, 2014) [3]. The pomegranate peels having good antioxidant activity as compared to the pulp and seed portion of fruit. Pomegranate fruits peel is an inedible part obtained during processing of pomegranate juice. Pomegranate peel is a rich source of tannins, flavonoids and other phenolic compounds (Rowayshed *et al*., 2013; Ullah *et al.,* 2012) [12, 14]. The objective of this study is physio-chemical and sensory analysis of noodles fortified with cowpea flour and pomegranate peel powder.

Materials and Methods

Procurement of raw materials

Wheat flour, cowpea flour, pomegranate peel powder, salt and guar gum for noodles preparation were purchased from local market of Nashik, Maharashtra, India

Development of cowpea flour

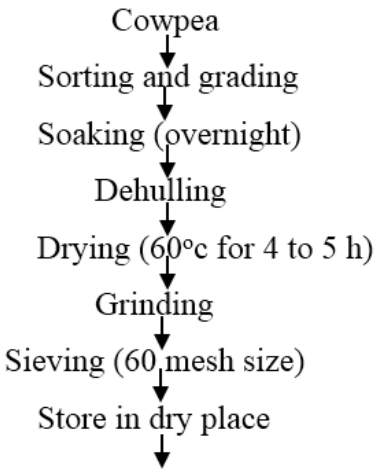

Fig 1: Development of cowpea flour

Development of pomegranate peel powder

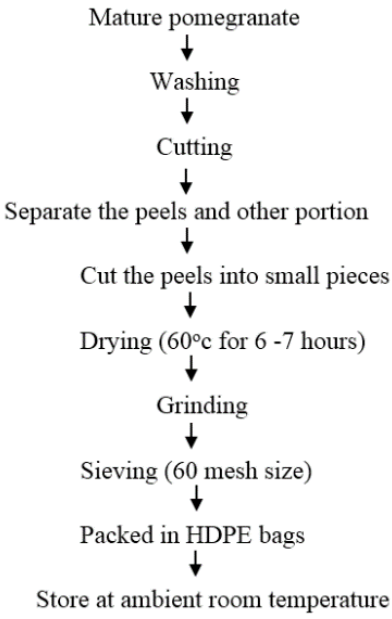

Fig 2: Development of pomegranate peel powder

Table 1: Sample formulations for 1 kg production of noodles

Sample	*WWF	*DCF	*PPP
A	850 gm	100 gm	50 gm
B	900 gm	50 gm	50 gm
C	830gm	100 gm	70 gm

*WWF- Whole Wheat Flour*DCF-Dehulled Cowpea Flour*PPP-Pomegranate Peel Powder

Each sample contains 5gm of guar gum and 20 gm of salt for 1 kg production of noodles.

Preparation of Noodles

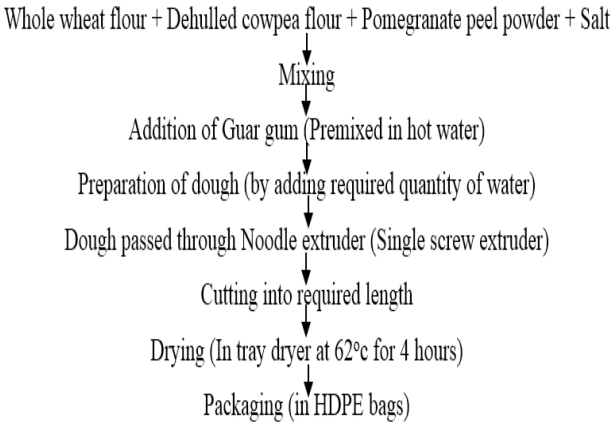

Fig 3: Preparation method of noodles

Fig 4: Noodle samples

Chemical Composition

Moisture, ash, fat and protein content were determined according to AOAC (2000) [1] methods. Protein content was obtained by using conversion factor of 6.25, Dietary fiber was determined by (IS: 11062). Total carbohydrate content was determined by using Anthrone method AOAC (1990) [2]. The measurement of total phenolics (TPs) content was conducted according to the modified Folin–Ciocalteu colorimetric method (Singleton *et al*., 1999) [13].

Physical characteristics of noodles

Cooking Time

Optimum cooking time of noodles was determined according to method of Baskaran *et al*., (2011) [4]. The noodle sample was boiled in a bowl at 100 ºC temperature and time was recorded. One strip of noodle was crushed in every 1-minute interval for checking the cooking time.

Cooking Loss

Cooking loss was calculated according to Bahnassey *et al*. (1986) [5]. Cooking loss was determined by collecting the cooking and rinse water in a preweight Erlenmeyer glass beaker, which was then placed in an air oven at 100 ºC and the water evaporated to dryness. The residue was weighed and reported as a percentage of dry noodles.

Weight Increase
Weight increase was evaluated according to Ozkaya and Kahveci (1990) [11]. After cooked and drained noodles were rested for 5 minutes, the weight was recorded and percent weight increase was calculated on the basis of difference between the weight of cooked and uncooked noodles.

Sensory Evaluation
Sensory evaluation of noodle samples was performed by 30 semi trained panelists, who are regularly consuming noodles. The 9-point hedonic scale and composite scoring tests were used to carry out sensory evaluation. They were assessed noodles in terms of appearance, texture and taste properties. Overall acceptability score was calculated by averaging the whole sensory attributes.

Results were expressed as mean values ± standard deviation

Results and Discussion
Proximate composition of ingredients
The proximate composition of wheat flour, dehulled cowpea and pomegranate peel powder is shown in Table 2. The dehulled cowpea was rich in protein content 23.12 % as compare to wheat flour and pomegranate peel powder. The pomegranate peel powder had highest dietary fiber (11.22 %) than wheat flour and dehulled cowpea. The pomegranate peel powder contains total phenolics 27.92 %.

Table 2: Proximate composition of Ingredients

Composition	Wheat flour	Dehulled cowpea	Pomegranate peel powder
Protein (%)	9.2 ± 0.02	23.12 ± 0.03	3.10 ± 0.05
Fat (%)	2.01 ± 0.10	1.62 ± 0.09	1.73 ± 0.12
Carbohydrates (%)	68.0 ± 0.13	62.86 ± 0.14	80.50 ± 0.10
Dietary Fibers (%)	10.4 ± 0.11	0.48 ± 0.17	11.22 ± 0.12
Ash (%)	1.8 ± 0.01	1.03 ± 0.01	2.12 ± 0.01
Total Phenolics (%)	-	-	27.92 ± 0.02

The noodles samples prepared using different proportion of wheat flour, dehulled cowpea flour and pomegranate peel powder is shown in Figure 4. Table 3. showed the proximate analysis and total phenolic content of noodle samples. The protein content of noodles samples ranged from 9.55 to 10.14 %. The high protein content observed in sample A and C due to highest amount of dehulled cowpea flour. The carbohydrate content of all three noodle samples were not vary among them. The fat content of sample A, B and C were 1.94 to 1.97 %. The fiber content was 8.94 to 9.46 %. Sample C contains higher fiber (9.46%) than sample A and B due to more pomegranate peel powder. The ash content of sample C was higher than sample A and B due to pomegranate peel powder. The total phenolic content was more 15.24 % in sample A. The high quantity of phenolic compounds due to pomegranate peel powder.

Table 3: Proximate composition of noodle samples

Sample	Protein (%)	Carbohydrates (%)	Fats (%)	Fibers (%)	Ash (%)	Total phenolics (%)
A	10.01 ±0.05	68.08 ± 0.12	1.94 ± 0.02	9.03 ± 0.21	1.79 ± 0.01	12.56 ± 0.03
B	9.55 ± 0.07	68.34 ± 0.15	1.97 ± 0.06	8.94 ± 0.23	1.83 ± 0.01	11.74 ± 0.04
C	10.14 ± 0.05	68.35 ± 0.14	1.94 ± 0.03	9.46 ± 0.22	2.82 ± 0.02	15.24 ± 0.04

Physical characteristics of noodles
Physical characteristics of noodles consist of cooking time, cooking loss and weight increase. The result of cooking time (Table 4) show that Sample C has less cooking time as compare to other two samples Table. This is due to increase in proportion of cowpea and pomegranate peel powder does not affect much cooking time.

Cooking loss is indicated by the loss of solid materials contained in noodle during cooking. The results of cooking loss (Table 4) shows that loss of solids or leaching of solids increases as the proportion of whole wheat flour increases. It is because of the starch, as it is easily leach out while cooking. Sample C was required lesser time than sample A and sample B.

Table 4: Physical characteristics of noodles

Sample	Cooking time (minute)	Cooking loss %	Weight before cooking	Weight after cooking
A	10:48 ± 0.26	5.4 ± 0.31	10 gm	27.1 gm
B	10:27 ± 0.35	5.0 ± 0.26	10gm	28.2 gm
C	9:33 ± 0.42	2.7 ± 0.27	10gm	26.8 gm

Cooking loss is indicated by the loss of solid materials contained in noodle during cooking. The results of cooking loss (Table 4) shows that loss of solids or leaching of solids increases as the proportion of whole wheat flour increases. It is because of the starch, as it is easily leach out while cooking. Sample C was required lesser time than sample A and sample B.

Weight Increase
Table 4 showed weight increase after cooking. Cooking yield is depending on the ability of noodle to absorb water during cooking. The water absorption is depending upon particle size of ingredients. Sample A and B had more weight increase than sample C.

Sensory Analysis

Table 5: Result of Composite score test

Sample	Color	Texture	Taste	Overall acceptability
A	5.9 ± 0.18	5.8 ± 0.34	6.53 ± 0.28	6.07 ± 0.25
B	7.4 ± 0.21	7.73 ± 0.21	7.43 ± 0.27	7.52 ± 0.24
C	7.8 ± 0.28	7.58 ± 0.32	7.65 ± 0.27	7.67 ± 0.29

The sensory analysis of noodles was carried out using 9th point hedonic scale. The results of sensory evaluation show that, 'Sample C' was more acceptable as compare to sample A and sample B. In composite score test sample B had high score in textural property but sample C had high scores in color and flavor attributes, therefor overall acceptability of Sample C was more compare to other two samples. The sensory analysis result also shows that, as the proportion of wheat flour increases acceptability deceases because it gives grainy texture. Sample C also had higher proportion of pomegranate peel powder i.e. 70 gm for 1 kg production of noodles and it does not affect any sensory characteristics.

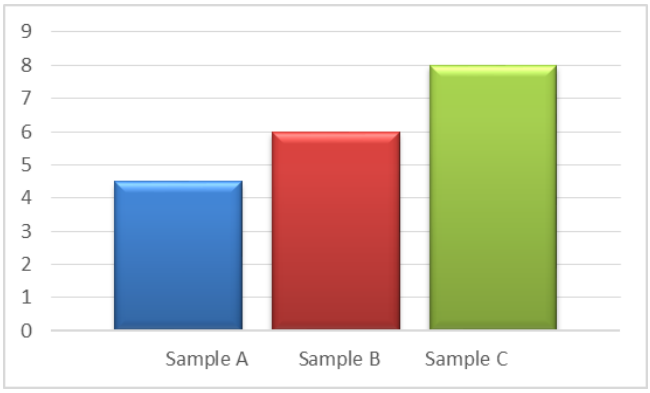

Fig 5: Sensory score of 9th point hedonic scale

Conclusion

The results of present study suggest that dehulled cowpea flour and pomegranate peel powder incorporation into whole wheat flour noodles up to level of 10% and 7% respectively, seems acceptable in terms of physicochemical and sensory attributes. Fortified noodles are inexpensive, highly nutritious and complete protein source, which can help to eliminate the major nutritional problem in developing and underdeveloped countries i.e. protein calorie malnutrition. Fortified noodles will improve the nutritional quality of diets and health of people. To reduce the cooking loss and cooking time of fortified noodles are the subjects of further investigation.

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