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PHYSICO-CHEMICAL, SENSORY AND PHYTO-CHEMICAL PROPERTIES OF INSTANT DRY SOUP MIX MADE BY USING BANANA PEEL AND WATER CHESTNUT

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ABSTRACT
Instant dry soup mix was prepared using water chestnut (*Trapa natans*) as a source of starch. Banana peel was added to enhance the nutritional properties of the developed soup mix as it is a rich source of fibres, polyphenols and antioxidants. Three different formulations were made wherein the level of water chestnut and banana peel were varied and the level of other ingredients was kept same. These formulations were compared with the market sample. Physico-chemical analysis showed no significant difference ($p > 0.05$) in the moisture and protein content of the developed soup samples and the control however crude fibre and ash contents were significantly higher ($p < 0.05$) than the control. Formula F2 showed higher sensory scores compared to the other formulations and was optimized. The antioxidant activity, flavonoid content and phenol content of optimized soup mix was found to be 0.126mMTR, 504 mg QE/100g and 760 mg GAE/100g respectively. The resultant soup mix guaranteed good sensorial properties, high fibre content (21.8%), good nutritive value, acceptability and lower cost than similar products available in market.

KEYWORDS: *Instant soup, water chestnuts, banana peel, physicochemical properties, phytochemical properties.*

Practical applications
Water chestnut is an underutilized crop and contains myriad of essential components. It has not been utilized fully in food industries, apart from a few investigations suggesting its incorporation in bakery products. Banana peel is a waste product and can be used for development of various products with high nutritional profile. This study can help industries develop food products from water chestnuts and banana peel and also help researchers for further advanced research on these underutilized products.

INTRODUCTION
Commercially prepared instant soups (canned, dehydrated and frozen) are gaining importance in world markets and are replacing homemade soups (Komarik *et al.* 1975), as preparing a soup with good appeal is a time consuming process. Dry soup mixes containing vegetables in many forms are second in popularity only to canned soups. Incorporation of phytochemical rich ingredients will be beneficial since these prevent free radicals from damaging human health. In comparison to freshly prepared soup, instant dry soup possesses desired quality, representing a dominant flavour and aroma of the ingredients used (Thorner *et al.* 1973).

Generally the starches used in soups are from wheat, corn and potato sources. Hence, an underutilized and cheaper source of starch, as water chestnut could be useful in the production of soups. Water chestnut is highly nutritive, containing about 16% starch as reported by (Shalabh *et al.* 2012), essential minerals (1.33%) and proteins (1.87%) (Saxena *et al.* 2010), but has failed to get all important attention of food processors. Non conventional starch sources are being explored constantly to meet the growing demands of food industries (Wani et al. 2012; Gul et al.2014, Rafiq et al. 2016).

A lot of work has been carried out on the properties of starch extracted from water chestnut (Gani *et al.* 2010; Gul *et al.* 2014). No work has been reported on its utilization and potential in soup preparation; however, a study has been carried out on its potential in preparation of cookies (Singh *et al.* 2011) and cakes (Mir *et al.* 2014). Starch has the property of imparting texture and consistency by acting as a thickener, stabilizer and

gelling agent (Wani *et al.* 2012). This thickening property of starch is utilized here in the preparation of soup.

India is the largest producer of banana with a production of 54.5 thousand tons (FAO, 2012). Significant quantities of banana peels, equivalent to 40% of the total weight of fresh banana, are generated as waste product in industries producing banana based products (Tchobanoglous *et al.* 1993). At present, these peels are mostly dumped as solid waste at large expense. This might be due to unknown benefit of their commercial application. These peels contain large quantities of nitrogen and phosphorus and its high water content makes it susceptible to modification by microorganisms (Gonzalez *et al.* 2010). It is thus significant and even essential to find applications for these peels to avoid environmental problems (Zhang *et al.* 2005) while helping increase the nutritional profiles of the formulated food products. Banana peel is rich in dietary fibre, proteins, essential amino acids, polyunsaturated fatty acids and potassium. A high dietary fibre content of banana peel (about 50 g/ 100 g) is indicative of a good source of dietary fibre (Emaga *et al.* 2007). Dietary fibre has shown beneficial effects in the prevention of several diseases, such as cardiovascular diseases, diverticulosis, constipation, irritable colon, colon cancer, and diabetes (Rodriguez *et al.* 2006).

A lot of work has being carried out by researchers on its utilization. So far it has only been used as a novel substrate for cellulase production (Sun *et al.* 2011), a functional ingredient in yellow noodle preparation (Ramli *et al.* 2009), and alcohol production (Dhabekar & Chandek, 2010). High content of dietary fibre in the peel, determines its possible use as a functional ingredient in starch based products such as soups. Keeping in view the possible benefits of water chestnuts and banana peel, present study was carried out to develop instant soup mixes prepared from water chestnuts and banana peel.

MATERIALS AND METHODS

Water chestnuts were procured from local market in Srinagar district of Jammu and Kashmir, India. Bananas, spices, salt and sugar were purchased from local market at Sangam Vihar, South Delhi, India.

Preparation of raw materials

Water chestnuts were peeled and cut into 4.0 ± 0.4 mm size pieces that were then immediately immersed in water containing 0.5 g/100 g potassium metabisulfite and 1.0 g/100 g citric acid for 30 min. Slices after pre-treatment were dried on a perforated tray drier at 70˚C for 24 h. Dried slices were grinded by a laboratory-grade grinder (M/s. Sujata, New Delhi, India) and passed through 177 µm sieve to obtain fine powder of uniform size and stored in airtight packs at 4˚C till further use (Mir *et al.* 2014).

Bananas were washed and peeled to remove from the flesh and peels were cut into small slices. To reduce enzymatic browning, peel slices were dipped in 0.5% (w/v) citric acid solution for 10 min, drained and freeze dried. The dried peels were ground in a laboratory grinder (M/s. Sujata, New Delhi, India) and passed through 177 µm sieve to obtain fine powder of uniform size and stored in airtight packs at 4˚C till further use

Product Formulation

The ingredients were weighed and mixed in different proportions to form three different formulations. Formulation F1 contained water chestnut 45g & banana peel 25g, F2 contained water chestnut 55g & banana peel 15g and F3 contained water chestnut 65g & banana peel 5g. Sugar 15g, salt 8g and spice mix 7g (onion powder, garlic powder, coriander, pepper) were added in same proportion to all the formulations. Knor vegetable soup (Hindustan Unilever Limited, Mumbai, India) available in the market was taken as a control sample.

Physico-chemical analysis

Moisture, ash and fat content were determined according to AOAC (1995) methods. Protein and dietary fibre content was determined AACC (2000) methods. Carbohydrate content was determined by difference method and the energy value of the final product was determined theoretically by calculating energy values from the value of oil/fat, protein and carbohydrates.

Descriptive Sensory analysis

The descriptive sensory analysis for various attributes (taste, flavor, colour, consistency, and overall acceptability) of soups was carried out on a 9-point hedonic scale by semitrained panelists (Land & Shepherd, 1988).

Phytochemical analysis

Total phenolic content (TPC) was carried out using gallic acid as a positive control as per the method described by Elizabeth *et al.* (2007). Total flavonoid content (TFC) was determined using Quercetin as positive control by the method of Chang *et al.* (2002). Antioxidant activity was determined by CUPRAC assay as described by Apak *et al.* (2004). Total phenolic content, flavonoids and antioxidant activity was calculated by constructing standard plots for gallic acid, quercetin and trolox using Microsoft Excel for Office 2007.

Statistical analysis

Experimental data were analyzed by one-way analysis of variance (ANOVA), and means were compared using Duncan's multiple range tests with significance defined at $p \leq 0.05$. All statistical analysis was performed using commercial statistical package SPSS (16.0, Chicago, IL).

RESULT AND DISCUSSION

Preparation of banana peel powder

Initially banana peels were dried using sun drying and oven dry method. The powder obtained using oven dry method was dark brown in colour [Fig. 2(a)] and resulted in a product of undesirable colour. Sun drying also failed

to produce a desirable colour hence a more modern method of drying called freeze drying was used. Freeze drying produced a desirable color [Fig. 2(b)].

Product formulation

Three formulations as given in Table 1 were prepared. Water chestnut was used as main ingredient in the preparation. Banana peel was added to add nutritional value. Salt and sugar were used as flavour enhancers and preservatives. Spice mix contained, onion, garlic, pepper and coriander. Onion was chosen as it is considerd as a flavouring agent and a condiment (Underriner *et al.* 1994). There are certain advantages of consuming garlic. It lowers the blood cholesterol by 10-12% (Holzgartner *et al.* 1992) and is able to reduce the occurance of stomach cancers. Moreover, garlic has a therapeutic effect on blood coagulation and platelet aggregation (Lawson, 1992) and acts as antibacterial and antifungal agent (Han *et al.* 1995). Black pepper contains piperine which stimulates the flow of saliva and gastric juices to aid digestion.

Reconstitution of soup mixture

Commercially soup mixes are reconstituted by adding water in ratios ranging from 1:20 to 1:15. Reconstitution at a ratio of 1:20 resulted in a soup that was watery in appearance and was having less flavour. The ratio of 1:15 was found to be acceptable as the reconstituted soup possessed a desirable consistency and flavour.

Physicochemical analysis

Compositional analysis of water chesnut and banana peel powder is shown in Table 2. Moisture content of water chestnut powder was 17.30%. Total ash and fat content was found to be 1.7 and 1.3% respectively which is slightly higher than as reported by Saxena et al. (2010) as 1.33 and 0.36% respectively. Fibre content was found to be 1.31%, which is higher than as reported earlier. The difference may be due to geographical region. Total protein content was 1.87% which is similar to as reported by Saxena *et al.* (2010). Moisture content of banana peel powder was 7.3%. Fat content was found to be 7.9% which is lower than as reported by Phatcharaporn *et al.* (2009) as 13.1%. Ash and protein content was found to be 9.5 and 4.5% respectively, which is lower than as reported by Tartrakoon *et al.* (1999) as 14.58 and 4.77% respectively. Fibre content was found to be 31.7%. This might be due to the difference in varieties and due to geographical factors.

Data on compositional analysis (Table 3) revealed that there was no significant difference ($p > 0.05$) in the moisture and protein content of the soup samples when compared to control. However, a significant difference ($p < 0.05$) was found in fat, ash and fibre content of soup samples compared to the control. Fat content of the control sample (10.10±0.14) was significantly higher ($p < 0.05$) than the other formulations (F1, F2 & F3). Ash content of all the formulations was significantly higher than the control (4.30±0.20). Formula F1 showed the highest fibre content (23.22±0.37) followed by F2 (21.92±1.37) & F3 (19.80±0.77). A significant difference ($p < 0.05$) was found in the the energy value of soup samples when compared to control. Formula F3 showed the highest energy value of (365.00±3.33) while the control sample showed the lowest (290.9±9.30).The decrease in the fat content and increase in the fibre content of the soup samples might be due to the addition of banana peel in the mix. Increase in the energy value could be due to the water chestnut which is a good source of carbohydrate.

Sensory evaluation

The three prepared soup mix formulations along with the control sample were evaluated for colour, flavour, mouth feel and over all acceptability (Fig.1). Results showed that the control sample showed the highest score for color (8±0.02) followed by F2 (7.9±0.57) and F3 (6.5±0.97). Formula F1 showed the least color score of (5.3±1.06) and was found to possess dark color and off flavour. This could be due to the increased proportion of banana peel into the soup mix. Formula F2 showed the highest score for mouth feel (8.1±0.57) followed by control (7.6±0.85). Scores were less for F1 and F3. Flavour score (6.8±0.92) was maximum for formula F2 followed by control. Score was less in case of formula F1 (5.4±0.97). This could be due to the increased proportion of banana peel. The overall acceptability scores (7.8±0.35) were highest for formula F2 and on this basis it was optimized.

Phytochemical analysis

Phytochemical analysis (Table 4) of banana peel showed that the Total phenolic content (TPC) was 890 mg GAE/100g, the total flavonoid content (TFC) was 582 mg QE/100g and the antioxidant activity was found to be 0.198mMTR. Phytochemical analysis of the optimized sample that is formula F2 showed that the Total phenolic content (TPC) was 760 mg GAE/100g, the total flavonoid content (TFC) was 504 mg QE/100g and the antioxidant activity was found to be 0.126mMTR.

Table captions

Table 1: Different combinations of water chestnut, banana peel, sugar, salt and spice mix used to prepare soup mix.
Table 2: Proximate analysis of the raw materials.
Table 3: Proximate analysis of soup samples and comparison with control sample.
Table 4: Phytochemical analysis of banana peel powder and soup sample.

Table 1: Different combinations of water chestnut, banana peel, sugar, salt and spice mix used to prepare soup mix.

Ingredients	F1	F2	F3
Water chestnut (%)	45	55	65
Banana peel (%)	25	15	5
Sugar (%)	15	15	15
Salt (%)	8	8	8
Spice mix[a] (%)	7	7	7

a= spice mix (100%)- onion powder 50%, coriander powder 20%, garlic powder 20%, pepper 10%

Table 2: Proximate analysis of the raw materials.

Parameters	Water chestnut powder	Banana peel powder
Moisture (%)	17.10±0.16	4.5±0.02
Crude Fat (%)	1.35±0.02	7.9±0.20
Protein (%)	1.82±0.01	4.5±0.07
Ash (%)	1.7±0.11	9.5±0.07
Crude fibre (%)	1.31±0.05	31.7±0.85
Carbohydrate (%)	78.03± 0.65	70.5±0.35

Table 3: Proximate analysis of soup samples and control sample.

Parameters	Control	F1	F2	F3
Moisture (%)	10.08±0.06[a]	10.22±0.37[a]	10.67±0.58[a]	10.17±0.18[a]
Protein (%)	6.5±0.61[a]	6.55±0.05[a]	6.67±0.15[a]	6.60±0.25[a]
Crude fat (%)	10.10±0.14[a]	5.52±0.67[b]	6.00±0.40[b]	6.11±0.320[b]
Ash (%)	4.30±0.20[b]	7.13±0.11[a]	6.70±0.61[a]	6.37±0.91[a]
Crude fiber (%)	18.40±0.88[b]	23.22±0.37[a]	21.92±1.37[a]	19.80±0.77[ab]
Energy value[1] (cal)	290.9±9.30[b]	350.68±8.54[a]	360.00±7.35[a]	365.00±3.33[a]

Mean ±S.D. with different superscripts in a row differ significantly ($p<0.05$) (n=3)
[1] Energy value by theoretical method

Table 4. Phytochemical analysis

Parameters	Banana peel powder	Soup Mix
Total phenolic content (TPC)	890 mg GAE/100g	760 mg GAE/100g
Total flavonoid content (TFC)	582 mg QE/100g	504 mg QE/100g
Antioxidant activity	0.198mMTR	0.126mMTR

Figure caption

Fig. 1: Sensory evaluation of different composite samples of soup mix.
Fig. 2: Oven dried and freeze dried banana peel.

Fig. 1: Sensory evaluation of different composite samples of soup mix.

2(a) Oven dried banana peel

2(b) Freeze dried banana

Fig. 2: Oven dried and freeze dried banana peel.

CONCLUSION

Underutilized water chestnut and banana peel were utilized for the first time in the preparation of instant soup mix. Water chestnut provided an alternate source of starch. Banana peel incorporation made the soup mix flavonoid (504 mg QE/100g) and phenol (760 mg GAE/100g) rich. The antioxidant activity was found to be 0.126mMTR. The resultant soup mix guaranteed good sensorial properties, high fibre content, good nutritive value, acceptability and lower cost than similar products in the market. This experimentation was carried to commercialize the importance of underutilized crops. However, the effect of heat on the antioxidant properties and shelf life need to be studied.

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