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Nutrient composition, polyphenol content and antioxidant activity of millet based breakfast recipes

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Abstract: Breakfast recipes like *upma, dosa* and *thalipattu* prepared from different millets were analysed for nutrient composition, polyphenol content and antioxidant activity. Significant variation in nutrient composition was observed in different recipes. Moisture and protein content of *upma, dosa* and *thalipattu* ranged from 63.12 to 65.87, 37.75 to 47.42 and 41.59 to 47.16 per cent and 4.99 to 7.31, 9.67 to 11.46 and 8.63 to 12.19 per cent respectively. Most of the millet recipes exhibited high fat, ash and dietary fibre contents than rice. All millet recipes had higher polyphenol content and DPPH radical scavenging activity as compared to the rice and wheat recipes. A highly significant positive correlation was found between the polyphenol content and DPPH radical scavenging activity of the recipes. Thus as source of good dietary fibre, polyphenol and antioxidant activity, millet recipes can be suitable breakfast foods in the regular diet of diabetes.

Key words: Antioxidant activity, Millet recipes, Nutrient composition, Polyphenol

Introduction

Millets are a major food source in arid and semi-arid parts of the world. Millets are good sources of energy. They provide protein, fatty acids, minerals, vitamins, dietary fibre and polyphenols. Typical millet protein contains high quantity of essential amino acids especially the sulphur containing amino acids (methionine and cysteine). The millets are source of antioxidants, such as phenolic acids and glycated flavonoids. Polyphenols are a large and heterogeneous group of phytochemicals of plant-based foods, such as tea, coffee, wine, cereal grains, vegetables, legumes, fruits and berries. Growing evidence indicates that dietary polyphenols influence glucose and lipid metabolism and delay the onset of secondary complications of diabetes. Polyphenols in millets help in reducing the blood sugar level and the diabetic symptoms (Mishra, 2016). Some of the health beneficial qualities, excellent shelf-life and anti-fungal characteristics of the millets could be attributed to their polyphenol content. The millets are known for their richness in many edible phytochemicals such as polyphenols, pigments and phytate. In recent years, there is growing evidence that plant-foods polyphenols, due to their biological properties, may be unique nutraceuticals and supplementary treatments for various aspects of type 2 diabetes mellitus (Chethan, 2008). We can consume millets in different processing forms like steaming, roasting, popping, germinating, malting etc. But millets are considered as poor man's diet and it is taken as low status food by the elite groups because of their colour, flavour and astringency. However, several researches on value addition to millets have been done in the Department of Food Science and Nutrition, College of Rural Home Science, Dharwad. Itagi *et al.,* 2012 developed readymade foxtail millet mix for diabetics. Mannurmath *et al.,* 2015 developed little millet based composite flour bread. Yenagi *et al.,* 2016 developed nutraceutically enriched hydrothermally treated little millet *P. sumatrense* rice in the diet of Type II diabetes. In this study evaluation of selected types of traditional recipes have been done for their nutritional and therapeutic quality by incorporating millets by replacing staple cereals like rice and wheat and the nutrient composition, polyphenol content and antioxidant activity have been studied.

Material and methods

The different millets like little millet, foxtail millet, ragi and pearl millet, rice and wheat flour and semolina were obtained from local market. The other functional ingredients like pulses, vegetables etc. were also procured from the local market. Traditional recipes like upma, dosa and thalipattu were prepared by using local traditional methods as per the methods in the book by Yenagi *et al.,* 2013 and evaluated for nutritional and therapeutic quality during 2015-16. *Upma i*s a common South Indian breakfast dish, cooked as a thick porridge from dry, roasted semolina or rice. *Dosa* is a fermented breakfast food made usually from rice flour and black gram *dal* and is a staple dish in South India. *Thalipattu* is a type of savoury multi-grain pancake popular in Western India and is a special dish of Maharashtra and Karnataka. The rice and wheat were replaced by different proportions of millets and the different ingredients added are presented in Table 1.

The cooked recipes were dried in the hot air oven at 50ºC, powdered and defatted and sample was prepared. The moisture, protein, fat, ash and dietary fibre contents were analyzed by following standard AOAC methods (Anon, 2016) and were expressed in g/100g. Known quantity of prepared recipes was directly taken for moisture analysis and for analysis of fat content, sample was not defatted. Defatted sample was taken for analysis of polyphenol content and antioxidant activity. The polyphenol content was determined Folin - Ciocalteau method by taking gallic acid as standard and was expressed as mg GAE/100g and the antioxidant activity was determined by using DPPH-radical scavenging activity method and as expressed in per cent(%) DPPH activity.

All chemical analyses was performed in triplicates (n=3) and the data was presented as mean ± SD. The difference between the moisture content, polyphenol content and

antioxidant activity between different recipes were done by one-way ANOVA. Correlation was done between polyphenol content and antioxidant activity

Results and discussion

The nutrient composition of millet incorporated recipes like *upma, dosa* and *thalipattu* varied significantly (Table 2). The moisture content ranged from 37.75 to 65.87g/100g. Among all the recipes, *upma* prepared from little millet, foxtail millet, wheat rawa and rice rawa had the highest moisture content whereas *dosa* prepared from little millet and pearl millet had the lowest. This is due to the increased water uptake during cooking of *upma* (Table 1) and also the retention of water during cooking. Among all the recipes, little millet *upma* (65.87g/100g) had the highest moisture content followed by foxtail millet *upma* (63.65g/100g) and the lowest was found in pearl millet *dosa* (37.75g/100g) (Table 2). In case of *upma* also there is addition of more ingredients as compared to dosa which may have led to increase in moisture content.

The protein content ranged from 3.50 to 12.19g/100g (Table 2). *Thalipattu* prepared from different millets showed significantly higher protein content than *upma*. This is attributed to the addition of bengal gram as a source of protein and functional ingredient in the recipe (Table 1). Pearl millet *dosa* and *thalipattu* exhibited higher protein content than other millet recipes. The highest protein content was found in pearl millet *thalipattu* (12.19g/100g) followed by wheat thalipattu (11.62g/100g) and the lowest was found in little millet *upma* (3.50g/100g). The higher protein content in pearl millet and wheat based recipes may be attributed to the higher protein content of the main ingredient (Gopalan *et al.,* 2010).

The range of fat content was between 1.39 to 5.65g/100g. *Upma* and *dosa* recipes possessed higher fat content as compared to *thalipattu.* This may be due to the release of bound lipids during these cooking methods. The highest fat content was possessed by pearl millet *dosa* (5.65g/100g) followed by foxtail millet *upma* (5.34g/100g) and rice *thalipattu* possessed the lowest (1.39g/100g). This may be due to variety of cooking methods and also release of bound lipids in case of pearl millet and foxtail millet and also due to its higher fat content (Gopalan *et al.,* 2010). Some essential fatty acids and also polyunsaturated fatty acids may also have formed which would have contributed to the fat content of the millet recipes. Millet is a starchy food with a 25:75 amylose to amylopectin ratio and it is fairly a good source of lipids (3-6%), having about 50 per cent of the lipids in the form of polyunsaturated fatty acids (Gopalan *et al.,* 2010).

The ash content of the recipes ranged from 1.30 to 3.17 g/ 100g. *Thalipattu* possessed the highest ash content compared to *upma* and *dosa.* This could be due to addition of more functional ingredients and also the mixing of different flours in case of thalipattu (Table 1). Foxtail millet *thalipattu* possessed the highest ash content (3.17g/100g) followed by little millet *thalipattu* (2.82g/100g) and the lowest was found in wheat rawa *upma* (1.30g/100g). This may be attributed to the significantly higher mineral content of millet recipes in comparison to rice and wheat recipes (Gopalan *et al.,* 2010).

The range of the dietary fiber content of the recipes was 1.52 to 7.28g/100g (Table 2). Thalipattu and dosa possessed the higher dietary fibre The dietary fibre content was found highest in pearl millet *dosa* (7.28g/100g) followed by pearl millet *thalipattu* (7.26g/100g) which was significantly higher than all other recipes. The lowest dietary fibre content was found in rice rawa *upma* (1.52g/100g). This may be attributed to the retention of more fibre during the shallow fat baking which may have retained in pearl millet and also the action of various enzymes during the process may have retained in pearl millet dosa. Increase in total dietary fibre content after application of high temperature short time treatment is also reported earlier in finger millet which may be mainly due to development of resistant starch (Dharmaraj *et al.*, 2012). Such redistribution of dietary fiber forms by the activities of intrinsic enzymes in rye flour (á- amylase, â-xylosidase, á -arabinofuranosidase, â - glucanase, endo-xylanase and cinnamoyl esterase) was also suggested by Hansen *et al.,* 2003. But in case of rice rawa *upma* low dietary fibre content was found. This could be due to the low fibre content in the refined raw rice grain and removal of bran layer of grains. In general, all the *thalipattu* recipes were having more dietary fibre content when compared to

Table 1. Recipes selected for the study

Name of the recipe	Millet incorporation (%)	Functional ingredients	Seasonal ingredients
Upma			
Little millet *upma*	100	Onion 25g, Bengal gram dhal,	
Foxtail millet *upma*	100	black gram dhal, groundnut	Water, Oil-25ml
Wheat rawa *upma*	-		
Rice rawa *upma*	-		
Dosa		butter milk 50ml	Water, Oil-15ml, green chilly 10g,
Little millet *dosa*	100		jeera powder-half tsp, coriander
Pearl millet *dosa*	100		leaves
Thalipattu		Cucumber-100g, Onion-25g,	Green chilly-10g Oil-25ml
Little millet *thalipattu*	Little millet (40) + Ragi (40)	Bengal gram-20g (except in	
Foxtail millet *thalipattu*	Foxtail millet (40) + Ragi (40)	ragi *thalipattu*)	
Ragi *thalipattu*	100		
Pearl millet *thalipattu*	Pearl millet (40) + Ragi (40)		
Wheat *thalipattu*	-		
Rice *thalipattu*	-		

Table 2. Nutrient composition of selected millet recipes (g/100g)

Recipes	Moisture	Protein	Fat	Ash	Dietary fiber	Carbohydrate
Little millet *upma*	65.87±0.61 [a]	3.50±0.09 [i]	5.06±0.09 [c]	1.54±0.02 [f]	2.18±0.04 [g]	21.84±0.49 [g]
Foxtail millet *upma*	63.65±0.17 [b]	6.19±0.17 [g]	5.34±0.02 [b]	1.31±0.01 [g]	3.74±0.06 [e]	19.75±0.15 [h]
Wheat rawa *upma*	63.12±0.53 [b]	7.31±0.16 [f]	3.60±0.05 [e]	1.30±0.02 [g]	2.23±0.08 [g]	22.42±0.21 [g]
Rice rawa *upma*	63.42±0.31 [b]	4.99±0.04 [h]	3.57±0.03 [e]	1.34±0.02 [g]	1.52±0.05 [h]	25.15±0.21 [f]
Little millet *dosa*	47.42±0.63[d]	9.67±0.11[d]	4.70±0.02 [d]	2.47±0.03 [d]	5.34±0.14 [b]	30.39±0.38 [d]
Pearl millet *dosa*	37.75±0.93[h]	11.46±0.08[b]	5.65±0.12[a]	2.58±0.03 [c]	7.28±0.08 [a]	27.92±0.43 [e]
Little millet *thalipattu*	47.16±0.16[d]	11.09±0.19[c]	2.50±0.01 [f]	2.82±0.01 [b]	3.12±0.04 [f]	33.30±0.25 [b]
Foxtail millet *thalipattu*	41.59±0.15[g]	11.84±0.41[b]	2.73±0.02 [f]	3.17±0.00 [a]	3.81±0.03 [e]	36.84±0.49 [a]
Ragi *thalipattu*	51.34±0.63[c]	8.63±0.20 [e]	2.15±0.17 [h]	2.78±0.03 [b]	3.96±0.08 [d]	31.14±0.42 [c]
Pearl millet *thalipattu*	41.61±0.60[g]	12.19±0.11[a]	2.62±0.16 [f]	2.61±0.30 [c]	7.26±0.09 [a]	33.70±0.24 [b]
Wheat *thalipattu*	45.63±0.19[f]	11.62±0.17[b]	1.52±0.01 [g]	2.79±0.01[b]	4.39±0.04 [c]	34.05±0.26 [b]
Rice *thalipattu*	46.37±0.39[e]	11.13±0.07[c]	1.39±0.23 [g]	2.25±0.02 [e]	4.46±0.03 [c]	34.39±0.41 [b]
F-value	1311.82	851.21	563.63	2915.21	1938.77	817.12
S.Em ±	0.35	0.22	0.17	0.08	0.14	0.31
C.D. (0.05)	0.75	0.30	0.18	0.04	0.12	0.58

others, even in case of rice and wheat *thalipattu.* This could be due to the addition of functional ingredients like pulses and cucumber which have more dietary fibre (Gopalan *et al.,* 2010).

The carbohydrate content ranged from 19.75 to 36.84g/100g. The highest carbohydrate content was possessed by foxtail millet *thalipattu* (36.84g/100g) followed by rice *thalipattu* (34.69g/100g) and the lowest was possessed by foxtail millet *upma* (19.75g/100g). This depended upon the moisture content and cooking method of the recipes.

Table 3 shows the polyphenol content and antioxidant activity of different recipes. Differences were also observed between the polyphenol content and antioxidant activity of different millet recipes which may be attributed to the distribution of polyphenols and antioxidants in different parts of the grain and also cooking methods and addition of various ingredients. Wide variation was observed in polyphenol content among the cereal and millets, which might be attributed to the variation in distribution of structural parts such as bran, endosperm and germ (Sridevi *et al.,* 2011). Thermal treatments caused distinct variations in different millets (Pradeep *et al.,* 2015). The polyphenol content ranged between 97.83 to 202.81mg/100g. This comes within the range of polyphenol content of milled fractions in whole grain cereals and millets which ranged from 78.63 to 363.26 mg/100g (Sridevi *et al.,* 2011). The highest polyphenol content was possessed by pearl millet *thalipattu* (202.81mg/100g) followed by pearl millet *dosa* (202.76mg/100g) and the lowest value was possessed by rice rawa *upma* (97.83mg/100g). The DPPH radical scavenging activity of different recipes ranged from 41.11 to 95.49 per cent. Little millet *thalipattu* possessed the highest DPPH radical scavenging activity (95.49 per cent) followed by pearl millet *dosa* (93.04 per cent). The lowest DPPH radical scavenging activity was possessed by rice rawa *upma* (41.11 per cent). Lowest polyphenol and antioxidant activity among all the types of recipes were found in rice recipes. This may be due to refining of grains and removal of bran layer in rice and wheat recipes which led to the decrease in polyphenol content. This shows that millets are rich in polyphenols and antioxidants. A highly significant positive correlation was found between the polyphenol content and DPPH radical scavenging activity of the recipes (r=0.673**). This may be due to synergetic action of polyphenols and antioxidants in all the food recipes.

Table 3. Polyphenol content and Antioxidant activity of recipes prepared from millets

Recipe	Polyphenol content (mg GAE/100g)	Antioxidant activity (% DPPH activity)
Little millet *upma*	138.10±0.20 [f]	56.51±0.37 [g]
Foxtail millet *upma*	133.76±0.82 [g]	52.97±0.55 [h]
Wheat rawa *upma*	107.37±0.34 [i]	53.4±0.27 [h]
Rice rawa *upma*	97.83±0.85 [j]	41.11±0.46 [i]
Little millet *dosa*	112.10±0.38 [h]	86.26±0.55 [c]
Pearl millet *dosa*	202.76±0.35 [a]	93.04±0.13 [b]
Little millet *thalipattu*	176.87±0.82 [c]	95.49±0.45 [a]
Foxtail millet *thalipattu*	174.00±0.39 [d]	64.26±0.73 [e]
Ragi *thalipattu*	185.18±0.20 [b]	85.93±0.76 [c]
Pearl millet *thalipattu*	202.81±0.38 [a]	75.45±0.59 [d]
Wheat *thalipattu*	148.05±0.69 [e]	61.45±0.26 [f]
Rice *thalipattu*	125.51±0.38	61.43±0.82 [f]
F-value	14324.35	3294.77
S.Em ±	0.50	0.50
C.D. (0.05)	1.56	1.57
	r=0.673**	

The study concludes that millet recipes are good sources of dietary fibre and polyphenol content, which are the important contributor for positive health benefits. The free radical scavenging active compounds in the millet recipes play a major role in the management of diabetes and other metabolic disorders. These recipes along with the recommendation for diabetics and also be introduced in the regular diet of healthy people. Thus, introduction of alternate cereal recipes in the regular diet can widen the food basket of cereals and increases the food value chain of millets.

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