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Nutritional characterization of cinnamon and turmeric with special reference to their antioxidant profile

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Abstract

This study investigates the integrated approach of spices against different life-threatening ailments. The cinnamon and turmeric were investigated for their nutritional composition, phenolic profile and antioxidant properties. Compositional analysis showed that both spices are an excellent source of protein and minerals. Regarding bioactive molecules extraction with ethanol exhibited highest polyphenols than that of methanol and water. The Most abundant phenolic contents were detected at 60 minutes' extraction time. The turmeric extracts showed highest β-carotene, DPPH, FRAP and total phenolic contents values in comparison with cinnamon and combination of both spices. The turmeric extracts showed higher β-carotene, DPPH, FRAP and total phenolic contents values in comparison with cinnamon and combination of both spices. Nine types of chicken soups were prepared after adding turmeric powder and cinnamon powder at 1.5, 2.5, 3.5 and 4.5g/100mL of each powder and 3.0g turmeric+ 3.0g cinnamon powder/100mL serving, correspondingly along with control. The supplementation of combined turmeric and cinnamon powder was found useful in enhancing the insulin secretion under hypercholesterolemic diet group. Furthermore, the values of kidney and liver functions tests were within the normal range showing the safety of turmeric and cinnamon supplementation. The turmeric powder performed better to control cholesterol, LDL and triglyceride. Besides, the combination of turmeric and cinnamon powder reduced glucose and enhanced insulin activity in hypercholesterolemic and hyperglycemic diet conditions. From the prompt investigation, it is inferred that turmeric and cinnamon based products are successful in decreasing lifestyle related disorders.

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Introduction

During current millennia scientists have momentously focused on the health-promoting effects of nutraceutical and functional foods catering human wellbeing. These functional foods and their bioactive moieties support the medical treatment of many life threating disorders like metabolic syndrome (Gibson *et al.,* 2004). Among many other food ingredients used in the diet based interventional strategies, phytochemicals derived from plants are very important, as not only they improve wellness and health but also act as the health-risk reducing factor (Shahidi, 2009).

These plant-based phytochemicals are accumulated on different functional foods, with special presence in spices. Spices not only develop our taste buds but are composed of remarkable list of phyto-chemicals, essential oils, minerals, vitamins and antioxidants that are vital to combat different diseases (Mishra and Behal, 2011). Although, in spices and herbs, the concentration of active ingredients is much lower than commercial drugs, however, the use of spices in medical benefits can be justified due to its easy absorption and less adverse effects (Balsano and Alisi, 2009).

Among major spices, turmeric (*Curcuma longa*) is commonly used as a coloring material and food additive with medicinal applications and biological actions (Abou-Elkhair *et al.,* 2014). Curcumin is the main and active component present in turmeric, containing 2 to 8% of the spice and found to have antioxidant (Karami *et al.*, 2011) and antiseptic activities (Negi *et al.*, 1999). Similarly, the beneficial effects of cinnamon such as its antioxidant, anti-inflammatory and anti-bacterial effects, are also well documented (Vinitha and Ballal, 2008). There are several compounds, present in cinnamon, are responsible for these beneficial effects including; cinnamaldehyde, eugenol, camphor and polyphenols (Rafehi *et al.*, 2012).

Although the spices have potential to treat metabolic morbodities, and many studies have used different turmeric and cinnamon species or preparations for various animal models (Kannapan *et al.*, 2006; Shen *et al.*, 2010; Mishra *et al.*, 2010; El-Desoky *et al.*, 2012). However, the synergistic role of these spices in regulating blood glycemic responses is not explicitly evaluated (Rafehi *et al.*, 2012; Allen *et al.*, 2013). Therefore, considering the health claims of turmeric and cinnamon, the present study was conducted to characterize locally grown turmeric (*Curcuma longa*) and cinnamon (*Cinnamomum cassia*), and to explore their potential to manage hyper-cholesterolemia and hyper-glycaemia through rat model, especially when used synergistically.

Materials and methods

Procurement and preparation of spices

Two indigenous spices of turmeric rhizome (*Curcuma longa*) and cinnamon bark (*Cinnamomum cassia* Presl; Chinese cinnamon) were purchased from vegetable research section, Ayyub Agriculture Research Institute (AARI), Faisalabad, Pakistan. The selected raw materials were cleaned to remove the adhered dirt, dust and other foreign debris. For turmeric/cinnamon powder preparation, the rhizome and bark were mechanically undergone four-step process *i.e.* heating, cracking, blowing and fine cutting with high-pressure air blow. The dehydrated material was ground to final powder for further use.

Proximate analysis

The turmeric and cinnamon were analyzed for their nutritional profile according to their respective protocols mentioned in AACC (2000).

Mineral analysis

Both turmeric and cinnamon samples were evaluated for mineral like sodium (Na) and potassium (K) were assessed by Flame Photometer whilst, iron (Fe), calcium (Ca), and manganese (Mn) were determined through Atomic Absorption Spectrophotometer through standard protocol of AOAC (2011).

Extraction and estimation of bioactive components

Bioactive components of cinnamon and turmeric powders were extracted by the protocol of Rusuk (2008) using water at three different time intervals 30, 60 and 90 min at constant temperature of 60°C.

Afterward, the resultant extracts except the water extract were filtered and subjected to rotary evaporator (Eyela, Japan).

Determination of total phenolics

Total polyphenols (TP) were measured by using Folin-Ciocalteu method following the protocol of Singleton *et al.* (1999) and were estimated as gallic acid equivalent (mg gallic acid/g).

DPPH Radical Scavenging Assay

The DPPH assay was carried out according to the method proposed by (Muller *et al.*, 2011) where 1, 1-diphenyl-2-picrylhydrazyl radical was used as a stable radical.

Antioxidant activity (AA)

Antioxidant activity of turmeric/cinnamon extracts was estimated based on coupled oxidations of β-carotene and linoleic acid through spectrophotometer at 470 nm (Tagaet *et al.*, 1984).

Statistical analysis

All data were determined by using the SPSS version 16.0 (SPSS, Cary, NC, USA) statistical analysis programme. P value of <0.05 was rated for significant differences among groups, and the comparison of means was made by using LSD (Steel &Torrie 1984).

Results and discussion

Proximate and mineral analysis

The mean values formoisture, fat, protein, fiber, total ash and NFE of turmeric and cinnamon spices were found to be 12.99±0.96 & 4.55±0.01, 4.47±0.2 & 2.99±0.05,5.12±0.3 & 3.01±0.03, 2.12±0.05 & 17.14±1.01, 4.1±0.10 & 2.01±0.04 and nitrogen free extract (NFE) as 71.2±3.14 &70.3±2.53 % respectively. Likewise values observed for minerals in turmeric and cinnamon as sodium (Na) 2.58±0.08 & 1.2±0.02, potassium (K) 180.56±10.45 & 122.5±9.21, calcium (Ca) 10.25±0.71 & 75±4.10, magnesium (Mg) 10.48±2.4 & 79.23±6.1, zinc (Zn) 0.36±0.03 & 2.01±0.01, manganese (Mn) 0.5±0.02 & 19.69±0.85 and iron (Fe) 2.05±0.04 & 6.0±0.01 mg/100g respectively.

Table 1. Nutritional Analysis of Turmeric and Cinnamon.

Constituents	Observed concentration	
	Turmeric	Cinnamon
Moisture	12.99±0.96	4.55±0.01
Fat	4.47±0.2	2.99±0.05
Protein	5.12±0.3	3.01±0.03
Fiber	2.12±0.05	17.14±1.01
Ash	4.1±0.10	2.01±0.04
NFE	71.2±3.14	70.3±2.53
Na	2.58±0.08	1.2±0.02
K	180.56±10.45	122.5±9.21
Ca	10.25±0.71	75±4.10
Zn	0.36±0.03	2.01±0.01
Mn	0.5±0.02	19.69±0.85
Fe	2.05±0.04	6.0±0.01

Effect of solvent

Means regarding the total phenolic contents antioxidant activity for cinnamon and turmeric extracted showed significant differences due to solvents and different time interval.The values for turmeric and cinnamon varieties in Table 2 showed that highest TPC (836.95, 648.96&661.70mg/100GAE) was observed in turmeric, cinnamon and turmeric+cinnamon followed by methanol extract (798.32, 577.31 & 598.48 mg/100GA) of turmeric, cinnamon & turmeric+cinnamon respectively. Whilst water extract of turmeric, cinnamon and turmeric+cinnamon exhibited lowest TPC (759.75,

519.42 & 525.87 mg/100GAE, respectively). Likewise, time period also affected significantly on TPC content of different spices. Maximum TPC recorded at 60 minutes extraction time was 964.78, 616.39 and 638.58 in turmeric, cinnamon & turmeric+cinnamon extracts, followed by 793.08, 577.43, 590.55 respectively at 90 minutes. The lowest TPC was noticed i.e. 637.17, 551.87, 556.92 for turmeric, cinnamon and turmeric + cinnamon at 30 minutes extraction time.

Table 2. Effect of treatments on TPC assay of Turmeric (mg/100GAE).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	700.15	1005.25	805.45	836.95[a]
Methanol	609.89	999.45	785.63	798.32[b]
Water	601.47	889.63	788.15	759.75[c]
Means	637.17[c]	964.78[a]	793.08[b]	

Means carrying different letters differ significantly;
Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water).

The current findings were similar to those reported by Nisar *et al.,* (2015) who evaluated the extraction with three different solvents at their different concentrations *i.e.* methanol (60%), methanol (80%), ethanol (60%), ethanol (80%), and aqueous extract were found as 523.87 mg GAE/100 g, 682.43 mg GAE/100 g, 678.76 mg GAE/100 g, 745.76 mg GAE/100 g, and 496.76 mg GAE/100 g, respectively. They conclude that ethanolic extract showed better TPC activity than methanol and water extracts. Nonetheless Kim *et al.*, (2011) conducted research and also reported promising TPC in a turmeric (582.8 mg GAE/100 g). Likewise, Kaur and Kapoor (2002) evaluated the bioactive phenolic compounds and antioxidant potential of Asian spices and vegetables including turmeric for its application in different functional foods.

Table 3. Effect of treatments on TPC assay of Cinnamon (mg/100GAE).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	600.31	700.59	645.98	648.96[a]
Methanol	555.63	600.45	575.85	577.31[b]
Water	499.68	548.12	510.45	519.42[c]
Means	551.87[b]	616.39[a]	577.43[ab]	

Means carrying different letters differ significantly;
Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water).

They analyzed that the TPC in turmeric varied from 1.72 to 7.46 g GAE/ 100g. Moreover Tacour *et al.* (2013) reported that the highest TPC was obtained in cinnamon bark ethanolic extract (1890.36 mg GAE/g DW) than turmeric extract (176.87mg GAE/g DW).

Extraction conditions, due to their impact on (overall) trial efficiency, are of prime importance. Comparatively higher antioxidant characteristic/activity of ethanolic extract in current experiment is even corroborated by the earlier the work of Nisar *et al.* (2011), who observed higher TPC and DPPH values for ethanolic extract of turmeric than those of methanol and water. They concluded that polarity of the solvents plays prime role for adequate recovery of phenolics. Previously, early

researches conclude that the polarity of solvent and solvent to material ratio were most important factors for maximum phenolic recovery (Frankel and Meyer, 2000; Bozin *et al.*, 2008 ;). Studies of Wang and Helliwell (2001) provide further corroboration, who concluded that, for the extraction of flavonoids, aqueous ethanol is superior as compared to aqueous methanol and acetone.

Table 4. Effect of treatments on TPC assay of Cinnamon+Turmeric (mg/100GAE).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	605.31	709.63	670.15	661.70[a]
Methanol	564.23	645.58	585.63	598.48[b]
Water	501.23	560.52	515.87	525.87[c]
Means	556.92[c]	638.58[a]	590.55[b]	

Means carrying different letters differ significantly;

Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water).

Table 5. Effect of treatments on DPPH assay of Turmeric (%).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	50	65	57	57.33[a]
Methanol	47	61	55	54.33[b]
Water	40	52	48	46.67[c]
Means	45.67[c]	59.33[a]	53.33[b]	

Means carrying different letters differ significantly;

Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water).

DPPH as antioxidant activity

The mean values of different extracts differed significantly for DPPH in spice extracts ($p< 0.05$) with both time intervals and solvents The DPPH assayis depicted in table. It was observed that the highest DPPH assay was in ethanolic extract as. For solventsregarding turmeric + cinnamon, turmeric and cinnamonshowed highest DPPH (53.00, 57.33and 48.00%, respectively) followed by values in methanolic extract of turmeric + cinnamon,turmeric, cinnamon was recorded as (42.27, 54.33 & 39.67%, respectively). The Lowest DPPH assay was observed in water extract of turmeric + cinnamon, turmeric & cinnamon (32.67, 46.67, and 30.33%, respectively). Correspondingly means for the effect of time periodindicated that maximum DPPH activity was noted at 60 minutes extraction time in turmeric, cinnamon &turmeric + cinnamon. 59.33, 41.00, 46.67 % respectively. Similarly, at 90 minutes 53.33% for turmeric, 38.00% for cinnamon & 42.00 cinnamon+ turmerictrend was observed. While extracts at 30 minutes presented lowest DPPH value.

Table 6. Effect of treatments on DPPH assay of Cinnamon (%).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	47	50	47	48.00[a]
Methanol	40	41	38	39.67[b]
Water	30	32	29	30.33[c]
Means	39.00[ab]	41.00[a]	38.00[b]	

Means carrying different letters differ significantly;

Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water).

Our results were in close agreement to those reported by Nisar *et al.* (2011) that free radical scavenging activities (DPPH) of three solvents of turmeric at their various concentrations i.e. methanol (60%), methanol (80%), ethanol (60%), ethanol (80%) and aqueous extract were found as 35.41%, 49.83% 46.16%, 52.19% and 31.33%, respectively. Results indicated that ethanolic extract showed better DPPH scavenge activity than methanol and water extracts. Furthermore Maizura *et al.* (2011) compared the antioxidant activity of different spices as alone or in combination and observed DPPH activity in turmeric water extract as 64.6 ± 2.4%. Likewise, Ana *et al.,* (2012) worked onthe free radical scavenging effect of turmeric, spinach, escarole, and watercress and recorded 57.6, 50.9, 48.1, and 44.0 µmolTrolox/g, respectively. DPPH activity is also higher in turmeric in the present study. Druzynska *et al.,* (2007) depicted that DPPH activity is not only dependent on solvent used for extraction but also on time, that's why highest DPPH scavenging ability was observed in extracts obtained at optimum time of 60 min.

Table 7. Effect of treatments on DPPH assay of Cinamon+Turmeric (%).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	51	59	50	53.33[a]
Methanol	42	45	43	42.27[b]
Water	30	36	32	32.67[c]
Means	41.00[b]	46.67[a]	42.00[ab]	

Means carrying different letters differ significantly

Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water).

Table 8. Effect of treatments on FRAP assay of Turmeric (µmol F/gdw).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	111.25	151.78	135.69	132.91[a]
Methanol	97.28	137.45	119.48	118.07[b]
Water	89.24	121.25	108.52	106.34[c]
Means	99.26[c]	136.83[a]	121.23[b]	

Means carrying different letters differ significantly;

Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water).

Ferric Reducing Antioxidant Power (FRAP) assay

The mean values for FRAP in spice extracts differed significantly with both time intervals and solvents ($p<0.05$).The results showed that mean values for the effect of solvents proved that aqueous extract showed lowest FRAP in turmeric, cinnamon and turmeric + cinnamon (106.34, 80.73 & 84.5µmol F/gdw, respectively). Althought the highest FRAP potential was observed in ethanolic extract of turmeric, cinnamon and turmeric + cinnamon (132.91, 110.28 & 115.48µmol F/gdw, respectively) followed by methanolic extract (118.07, 97.15 & 101.16µmol F/gdw, respectively) of turmeric, cinnamon and turmeric + cinnamon. However, means for effect of time for Frap potential, indicated the similar trendas in Dpph and TPC.

The findings of present work were in line with the findings Maizura *et al.* (2011) who worked onantioxidant activity of turmeric alone and plants mixtures of kesum and turmeric and ginger & turmeric were 23.30, 27.5 and 25.3 µmol Fe/g, respectively. Lately Tacour *et al.* (2013) recorded better FRAP activity ($P<0.05$) in cinnamon (24.93 µmol F/gdw) and turmeric (5.980 µmol F/gdw).

Table 9. Effect of treatments on FRAP assay of Cinnamon (µmol F/gdw).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	99.25	121.58	110.02	110.28[a]
Methanol	79.45	112.36	99.63	97.15[b]
Water	69.32	93.25	79.63	80.73[c]
Means	82.67[c]	109.06[a]	96.46[b]	

Means carrying different letters differ significantly;

Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water).

Table 10. Effect of treatments on FRAP assay of Cinnamon+Turmeric (µmol F/gdw).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	105.33	125.87	115.25	115.48[a]
Methanol	85.63	115.23	102.63	101.16[b]
Water	72.69	96.89	82.56	84.05[c]
Means	87.88[c]	112.66[a]	100.15[b]	

Means carrying different letters differ significantly;

Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water).

β- Carotene antioxidant activity

Mean values indicated significant effect of solvents and time intervals on spices ($p<0.05$). Means for solvents exhibit highest β-carotene in ethanolic extract of turmeric, cinnamon and turmeric + cinnamon (64.33, 54.67 & 57.00%, respectively), followed by methanolic extract of turmeric, cinnamon &turmeric + cinnamon (60.00, 43.00 & 46.67%, respectively) and water extract of turmeric, cinnamon and turmeric + cinnamon (43.00, 36.33 & 40.33%, respectively). Moreover, means for effect of time intervals showed that maximum β-carotene activity was (60.00, 48.33, and 50.67, %) at 60 minutes extraction time in turmeric, cinnamon & turmeric + cinnamon respectively.

Table 11. Effect of treatments on β-Carotene assay of Turmeric (%).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	61	69	63	64.33[a]
Methanol	58	64	58	60.00[b]
Water	40	47	42	43.00[c]
Means	53.00[b]	60.00[a]	54.33[b]	

Means carrying different letters differ significantly;

Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water)

Table 12. Effect of treatments on β-Carotene assay of Cinnamon (%).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	52	59	53	54.67[a]
Methanol	42	47	40	43.00[b]
Water	36	39	34	36.33[c]
Means	4333[ab]	48.33[a]	42.33[b]	

Means carrying different letters differ significantly;

Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water).

Total antioxidant activity (β-carotene) results are corroborated by the work of Mustafa *et al.* (2012), who evaluated carrot's antioxidant activity. They used ethanol as solvent. Further studies that corroborate with the results of the present study by Ana *et al.* (2012), who work showed that turmeric (92.8%) and lettuce (90%) showed the highest β-carotene activity, while turnip (3.4%) presented the lowest result. Rusak *et al.* (2008) verified that aqueous ethanol is more efficient than water for continued extraction of 30 min.

Table 13. Effect of treatments on β-Carotene assay of Cinnamon+Turmeric (%).

Solvents	Extraction time			Means
	30 Min	60 Min	90 Min	
Ethanol	55	61	55	57.00[a]
Methanol	45	50	45	46.67[b]
Water	39	41	41	40.33[c]
Means	46.33[b]	50.67[a]	47.00[b]	

Means carrying different letters differ significantly;
Ethanol = (50% ethanol + 50% water); Methanol = (50% methanol + 50% water.

These findings are similar to the current trial that confirmed that ethanol is more efficient than methanol and water for prolonged extraction of 60 min.

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