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Effect of *Cosmos caudatus* Kunth. (Ulam Raja) Aqueous and Dry Extracts on the Physicochemical and Functional Properties, and Sensory Acceptability of Herbal Yellow Alkaline Noodles

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ABSTRACT

Introduction: *Cosmos caudatus* (Ulam Raja) is rich in phytochemicals and can be utilised in diet diversification strategies to improve the health of individuals. This study was designed to incorporate dry and aqueous extracts of *C. caudatus* for the preparation of herbal noodles. **Methods:** For this purpose, different proportions of dry extract (2, 4 and 6% dry extract) and aqueous extract (5, 10 and 15% aqueous extract) of *C. caudatus* were used. The physicochemical properties of noodles evaluated were pH, cooking time, cooking loss, texture and colour. Total polyphenol contents (TPC) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay were carried out to assess the antioxidant potential. Lastly, sensory appraisal of functional noodles was carried out to assess consumer acceptance and marketability. **Results:** The results on physicochemical properties indicated that the pH value of noodles varied from 8.66 to 10.47. In terms of textural analysis and colour properties, firmness and greenness (a*) were higher in dry extract noodles. TPC varied between 115 to 149 mg gallic acid equivalents (GAE/100g) whilst the highest DPPH free radical inhibition was exhibited in herbal noodles prepared using 4% dry extract (92.8%). In contrast, in terms of sensory appraisal, herbal noodles prepared with aqueous extract were more acceptable than dry extract noodles. **Conclusion:** *C. caudatus* can be utilised to prepare herbal noodles thus enhancing the dietary intake of phytochemicals especially antioxidants. Such functional foods can improve the health of consumers and offer the potential of protection against various ailments.

Key words: Antioxidants, *Cosmos caudatus*, DPPH assay, functional foods, herbal yellow alkaline noodles

INTRODUCTION

Functional foods and nutraceuticals have emerged as important components of the food supply chain as consumers are increasingly aware of the diet-health linkages. An acceptable working definition of functional food provided by various researchers is 'modified food that might perk up human health along with provision of some basic nutrients.' The functional food must show some concrete health benefits with an expected amount of consumption (Wong, Leong & Koh, 2006; Siró *et al.*, 2008). In the recent past,

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consumers trends have inclined towards nature leading to the development of a market for nutraceuticals and functional foods (Hoefkens, Verbeke & Van Camp, 2011). Peoples are also concerned about their dietary habits and lifestyles and government agencies along with health professionals are advising communities to include fruits and vegetables in their regular diets (Annunziata & Vecchio, 2011). Nature has provided us with thousands of fruits, vegetables, cereals grains, and legumes. Researchers across the globe are of the view that consumption of some of these plants is good for reducing the risk of various ailments including diabetes mellitus, cardiovascular disorders and cancer. In this regard, bioactive components present in these plants are responsible for the antioxidant activity of vegetables, fruits, and herbs (Butt & Sultan, 2013).

Nature has bestowed Malaysia with a wide variety of tropical fruits and vegetables along with some traditional herbs which possess health benefits (Loh & Hadira, 2011). Among these, green leafy vegetables possess antioxidant properties owing to bioactive molecules such as tocotrienols, tocopherols, thiols, phenols, terpenes, and dietary fibre (Mustafa *et al.*, 2010; Galanakis *et al.*, 2013). The Malays love to eat the leaves of *Cosmos caudatus*, locally known as Ulam Raja, with rice during their meals. The presence of several bioactive compounds coupled with a unique taste and aroma could be the reasons for its utilisation as an appetizer and food flavouring (Shui, Leong & Wong, 2005; Mediani *et al.*, 2012). *C. caudatus* contains appreciable quantities of bioactive components including quercetin, glycosides, and phytosterols, some of which possess radical-scavenging properties that function as natural antioxidants (Shaari *et al.*, 2003; Rasdi *et al.*, 2010; Mediani *et al.*, 2012).

In recent years, efforts have been initiated to incorporate bioactive molecules into dietary staples to enhance the wellbeing of consumers. Although, communities from the Association of South East Asian Nations (ASEAN) consume rice as a staple food, noodles in various, formulations, sizes and shapes are also included in the list of staple foods (Fu, 2008; Choo & Aziz, 2010). Typically, Asian noodles are made from wheat & rice flour and can be categorised into two general classes based on the ingredients used in production i.e. white salted noodles (WSN) and yellow alkaline noodles (YAN). The yellow colour of YAN is due to the reaction between the flavonoids in the wheat flour with alkaline salts (Asenstorfer, Wang & Mares, 2006; Gan *et al.*, 2009). The major purpose of this research is to develop a functional herbal noodle using *C. caudatus* leaf extract and to study the effects of different extracts of *C. caudatus* on the antioxidant and physicochemical properties, and sensory acceptability of the herbal yellow alkaline noodles.

METHODS

Cosmos caudatus Kunth. or locally known as Ulam Raja used in this study was purchased from the wholesale market at Seri Kembangan, Selangor, Malaysia. A branded wheat flour was bought from a leading flour supplier (Selangor, Malaysia). Common salt and vegetable oil used were purchased from the local supermarket in Sri Serdang, Selangor. Chemicals and reagents were purchased from local distributors i.e. HmbG Chemicals (Selangor, Malaysia), Acros Organics (New Jersey, USA), and Merck (Darmstadt, Germany). The *C. caudatus* leaves were thoroughly washed under running water to remove impurities. Excess water was drained and the leaves were cleaned with white cloth and left to dry in trays at room temperature (27±2°C).

Preparation of dry and aqueous extracts

C. caudatus leaves were freeze dried (Virtis Genesis 25 ES) by placing the cleaned leaves evenly in freeze dryer trays for 48 hours until the samples were completely dry according to the method described by Li *et al.* (2012) with slight modifications. The dried leaves were ground in a blender (Pensonic) and stored in reagent bottles covered with aluminium foil to protect them from light and stored at -20±2°C prior to analysis. For the preparation of aqueous extracts, 50 g of cleaned, fresh *C. caudatus* leaves were blended with 150 ml of distilled water (1 part herb and 3 parts liquid) approximately for 1 min. The blend was filtered using sieve (200μm) to remove any coarse materials and kept in amber coloured reagents bottles to protect from light at -20±2°C for further analysis.

Preparation of yellow alkaline herbal noodles

Herbal yellow alkaline noodles were made in the laboratory by using the methods of Miskelly, Moss & Moss (1986) and Gan *et al.* (2009) with some modifications. Noodles formulation comprised of 100 parts of wheat flour, 34 parts of distilled water, 1 part of common salt (NaCl), and 1 part of alkaline salt (comprising of 60% sodium carbonate (Na_2CO_3) and 40% potassium carbonate (K_2CO_3). The common salt and alkaline salt were dissolved in distilled water to form the alkaline salt solution. The flour was uniformly mixed for 30 s at speed 2 using a mixer (Kitchen Aid Heavy Duty, Michigan-USA). The alkaline salt solution was slowly added to the flour and was further mixed for 2 min. Later, the extract of *C. caudatus* was added every subsequent minute and the dough was kneaded continuously up to 4 min. The dough was compressed using a fabricated compressor into a slab of about 600 mm x 25 mm x 1.6 mm in dimension. The dough slab was passed through a pair of rollers of a noodle machine (Orimas MT25B, Kuala Lumpur, Malaysia) for seven successive sheeting steps. But, after the fifth sheeting step, the dough was allowed to rest for 15 min at room temperature (27± 2°C) before further sheeting. The dough sheet was cut into noodle strands using a cutting roll after the seventh sheeting step. The noodles were parboiled for 50 s in boiling distilled water at a ratio of 1 part of noodles to 10 parts of water. They were then cooled immediately under a running tap water for 1 min, drained to remove surplus water in the open air for 10 minutes, coated with vegetable oil (3% w/w) and packed in polyethylene bags.

Physicochemical properties

pH value

Parboiled yellow alkaline herbal noodles (10 g) were homogenised in 90 ml of distilled water (Li *et al.*, 2012) using a homogeniser (Heidolph DIAX 900, Toronto, ON). The pH value was measured using pH meter (Mettler-Toledo Delta 320).

Optimum cooking time and cooking loss

Optimum cooking time and cooking loss of the herbal yellow alkaline noodles were evaluated according to the Official Method No. 16-50 of the AACC (2000).

Texture profile analysis

The texture profile analyses (TPA) of yellow alkaline herbal noodles with *C. caudatus* extract were carried out using Texture Analyzer (TA-TX2, Stable Micro Systems, Surrey, UK) fitted with a 2.5 kg load cell. The data was then processed using a personal computer running Texture Expert software. Rig calibration was performed before starting the analysis and distance was set at 10 mm. The noodle strand of each different treatment was placed individually on a flat metal plate and compressed twice to 70% of its original height using the texture analyser settings as follows: pre-test speed: 2.0 mm/s; test speed: 2.0 mm/s; post-test speed; 2.0 mm/s; mode: strain; strain: 70%; trigger force: 10 g. The firmness, springiness, cohesiveness, and chewiness characteristics were determined.

Colour parameters

An Ultra-scan Hunter Lab Colour-meter (Hunter Associate Laboratory Inc., Reston, USA) was employed for colour intensity measurements of the colour of herbal noodles with different proportions of *C. caudatus* extract. The data were collected and processed using a personal computer running on Easy-Match QC Data System software with L, a, b, values and expressed as L (lightness; 0 = black, 100 = white), a (−a = greenness, +a = redness), and b (−b = blueness, +b = yellowness) values.

Antioxidant properties

Extract preparation

The extraction method used was according to Choo & Aziz (2010) but with some modifications. Parboiled noodle samples (100 g) were mixed with 200 ml of distilled water. The mixture was homogenised using a homogeniser (Heidolph DIAX 900, Toronto, ON) and filtrated through Whatman No. 1 filter paper. The supernatant was collected and freeze-dried for about 2 days and stored in a freezer (0°C) until further use.

Total phenolic content

Total phenolic contents (TPC) were measured according to the method of Choo & Aziz (2010). First, 5 ml of DMSO was used to dissolve 5 mg of freeze-dried extracts of herbal noodles. Then, 0.5 ml of the resulting aliquot was added to 1 ml of 50% Folin-Ciocalteau reagent and incubated for 3 min at 20±2°C. Afterward, 3 ml of 1% Na_2CO_3 was added to the mixture and thoroughly vortex-mixed and incubated for a further 30 minutes. Absorbance of the mixture was read at 760 nm, using a spectrophotometer (Thermo Scientific Genesys 20, USA) and the results were expressed as milligrams of gallic acid equivalents per 100 g of noodle sample (mg GAE/ 100g).

DPPH free radicals scavenging assay

The DPPH assay was carried out using the method described by Prabhasankar *et al.* (2009) with slight modifications. Briefly, 0.10 mM of DPPH was dissolved in 100 ml of 99.9% ethanol. Stock solutions of aqueous and dry extracts (0.5 g) were dissolved in 100 ml distilled water. Serial dilutions of varying concentrations (50, 100, 500, 1000, 3000 and 5000 ppm) were prepared from the stock solution. A 2 ml DPPH solution was mixed with 2 ml of each dilution in the test tubes and shaken well for at least 15 s. Finally, 2 ml of 99.9% ethanol was mixed with 2 ml of DPPH solution (used as blank) and the test tubes were kept in the dark for 1 h. The absorbance of blank (control) and all the samples were taken at 517 nm. The scavenging effect (%) was calculated according to the following equation:

% Inhibition DPPH =
(AbsDPPH −Abssample) x 100 (Eq. 1)

where AbsDPPH is the absorbance of the DPPH solution without the extracts, and Abssample is the absorbance of sample solution.

Sensory appraisal of herbal yellow alkaline noodles

Sensory analysis on the acceptability of herbal noodles was carried out using 50 untrained panellists, comprising healthy undergraduate students and laboratory staff at the Sensory Room, Faculty of Food Science and Technology, UPM. Noodles were served to the panellists with a chicken soup as carrier in small containers which were kept warm until serving. The panellists were asked to taste and express their opinion about the acceptance of the product by giving a score to noodle attributes of aroma, colour, taste, texture and overall acceptability based on the nine-points hedonic scale (Score 1 = dislike extremely; Score 5 = neither like nor dislike; Score 9 = like extremely). Filtered water was provided to the panellists for rinsing their mouths between the samples. In each session, panellists were seated in separate booths equipped with white fluorescent lighting. Information such as frequency of noodle consumption, age, occupation, and willingness to purchase the product if available in the market was also surveyed using an evaluation form.

Statistical analysis

All measurements were performed in duplicate. Results were expressed as mean values ± standard deviation. The results were analysed using one-way analysis of variance (ANOVA) to check the level of significance and comparison of means was performed using Duncan's test at a significance level of $p<0.05$. Statistical analyses were run using Statistical Analysis System (SAS Institute, Cary, NC) version 9.1 and Microsoft Excel 2007.

RESULTS AND DISCUSSION

In this study, we investigated the role of *C. caudatus* in the preparation of herbal yellow alkaline noodles. The results and relevant discussion pertaining to the different parameters are presented herein.

Physicochemical properties of yellow alkaline herbal noodles

The results regarding pH of control and noodles incorporated with different proportions of *C. caudatus* extracts are shown in Table 1. All the samples showed significant differences ($p < 0.05$) for all the physicochemical properties studied. Control noodles had the highest alkalinity (pH 10.43) compared to other noodles. Noodles with 6% dry extract showed the least pH value (8.65) compared to a pH value of 9.23 in 15% aqueous extract. Overall, the yellow alkaline noodles with aqueous extracts showed a higher alkaline level compared to dry extracts noodles. Fu (2008) offers an explanation for the increase/decrease in pH of yellow alkaline noodles. Generally, pH is dependent on ingredients used in the formulation, for example, types of alkaline salts used results in different pH depending upon its strength. Moreover, alkaline pH is also indicative of some reactions involving gluten proteins. The reduction in pH of herbal noodles was due to the addition of the different types and amounts of *C. caudatus* extracts in the formulation.

Cooking time refers to the time needed to fully gelatinise the starch and this is marked by the disappearance of a white core in the noodles strands. The addition of *C. caudatus* extract affected the optimum cooking time of herbal noodles significantly (Table 1). The result indicated that there were significant differences in time required to cook the herbal noodles added with different types and proportions of *C. caudatus* extract. Control noodles required average cooking time of 4.0 min ($p < 0.05$) compared to cooking time of 150 s & 130 s for 5 and 10% aqueous extract, respectively. However, yellow alkaline noodles prepared with addition of 15% aqueous extract could be cooked in less time i.e. 70 s. It can be observed from the present study, that the optimum time for cooking was shorter than for the control noodles without the extract. Huang & Lai (2010) observed that a shorter cooking time was required for white salted noodles made of reconstituted flour. The differences in cooking time are due to interaction of components present in dry/ aqueous extracts with the gluten proteins (Nasehi *et al.*, 2009).

Cooking loss is an index of surface characteristics of noodles and it reflects the amount of solid loss during the cooking process. Cooking loss of less than 8% is considered acceptable for good quality pasta (Dick and Young 1988). Good quality flour used with high protein content in a range of 9 – 13% and low level of damaged starch and fine particles would produce noodles with good texture and strong gluten matrix formation during the mixing process. *C. caudatus* in dry form may not dissolve or uniformly distribute during mixing, thus reducing the strength of the gluten matrix (Fu, 2008). When cooking

Table 1. The pH value, cooking quality and textural profile of herbal yellow alkaline noodles prepared with aqueous and dry extracts of *Cosmos caudatus*

Treatment	*pH*	*Cooking loss*	*Optimum cooking time (s)*	*Firmness (g. force)*	*Cohesiveness*	*Springiness*	*Chewiness*
*Control	10.47 ± 0.020	2.93 ± 0.06bc	240.00 ± 30.00a	1209.19 ± 116.60b	0.801 ± 0.02a	0.952 ± 0.045a	1020.54 ± 89.75c
5% AE	9.86 ± 0.017	3.30 ± 0.17b	150.00 ± 30.00b	1286.49 ± 94.48b	0.813 ± 0.02a	0.970 ± 0.076a	1048.33 ± 58.87bc
10% AE	9.57 ± 0.040	3.33 ± 0.12b	130.00 ± 17.32b	1408.81 ± 136.66ab	0.797 ± 0.01b	0.971 ± 0.008a	1123.81 ± 113.64abc
15% AE	9.23 ± 0.006	3.96 ± 0.15a	70.00 ± 14.29c	1354.07 ± 161.23b	0.792 ± 0.02b	0.976 ± 0.006a	1021.04 ± 114.15c
2% DE	8.84 ± 0.011	2.23 ± 0.06d	50.00 ± 12.68c	1364.39 ± 97.69b	0.815 ± 0.01a	0.970 ± 0.009a	1075.53 ± 80.96bc
4% DE	8.74 ± 0.030	2.53 ± 0.06cd	40.00 ± 14.23c	1405.63 ± 126.00ab	0.788 ± 0.01b	0.975 ± 0.007a	1146.28 ± 100.6ab
6% DE	8.65 ± 0.017	4.30 ± 0.20a	50.00 ± 14.88c	1505.10 ± 148.98a	0.754 ± 0.01c	0.959 ± 0.046a	1222.78 ± 112.24a

AE = aqueous extract; DE = dry extract
* Control refers to yellow alkaline noodle without addition of the extract
*Each value represents the mean ± standard deviation of triplicate measurements. Mean values with different lowercase alphabets within the same column are significantly different at $p < 0.05$.

loss values of these noodles were taken into consideration, it was noted that herbal noodles with the highest concentration of *C. caudatus* aqueous extract had higher cooking loss (Table 1). The cooking loss increased from 2.5% in control noodles to 3.9% of 15% aqueous extract and 4.3% in noodles incorporated with 6% dry extract. The lowest cooking loss was observed in 2% dry extract with the percentage of losses being significantly lower than in the control noodles. This may be due to the presence of a lower concentration of the dry extract contributing to the formation of a stronger gluten network in the noodle structure. Prabhasankar *et al.* (2009) had reported that pasta prepared with 30% addition of wakame (*Undaria pinnatifida*) showed highest cooking loss as compared to other samples. Similarly, Nasehi *et al.* (2009), Boroski *et al.* (2011) and Li *et al.* (2012) also observed the same behaviour with the addition of soy flour, oregano, carrot leaf, and yam flour. It is evident from the present study that higher concentrations of dry extracts could interfere with the development of the gluten matrix in the noodles due to presence of higher amounts of total solids. Therefore, increasing the amount of *C. caudatus* extract to the noodles at certain levels technically hindered the uniform development of functional dough properties and hence will influence the cooking quality of the noodles. However, the cooking losses of herbal noodles at the concentration levels studied are within the acceptable range.

Texture profile analysis

The dry and aqueous extracts of *C. caudatus* affected the texture profiles of herbal noodles (Table 1) significantly. The incorporation of 10% aqueous extracts and 4% and 6% dry extracts of *C. caudatus* increased the firmness of alkaline noodles significantly ($p < 0.05$) when compared to the control. In general, the firmness of noodles increased with an increase in the amounts of *C. caudatus* extract from 1.209 to 1.505 kg force. The highest firmness was shown by noodles added with 6% dry extract. The solid particles of the dry extract interacted with the flour particle to confer an increase in noodle strength. The results in this study are in agreement with the findings of Li *et al.* (2012) who reported that the incorporation of different amounts of yam flour increased the firmness of salted noodles from 1.49 to 3.06 kg of force.

The incorporation of *C. caudatus* extract both in dry and aqueous forms affected the cohesiveness of herbal noodles. Addition of 6% dry extract showed a significant reduction ($p < 0.05$) in the cohesiveness value (0.754) compared to all the other noodles. The control, 5% aqueous extract, and 2% dry extract showed non-significant differences ($p > 0.05$) among them, while 10 and 15% aqueous extracts and 4% and 6% dry extract were significantly lower than the control. There were non-significant differences in springiness among the noodles samples. However, the chewiness property of noodles added with 6% dry extract was significantly higher than all the noodles samples. This increasing trend was similar to the firmness property of noodles. Control noodles showed the least value for chewiness and indicated that the force or pressure to compress the noodles require a lower energy probably due to noodles structure that is less compact (Li *et al.*, 2012).

Colour parameters

Colour is a key quality trait since it provides the visual impact and Asians prefer yellow alkaline noodles with bright yellow colour, free from any darkening or discolouration (Fu, 2008). Perceived red or dull and pale grey colours are undesirable traits for alkaline noodles (Asenstorfer *et al.*, 2006). The colour analysis indicated that the control noodles were significantly brighter as compared to other noodles (Figure 1). The negative a* values indicating greenness was higher in all noodles prepared with aqueous & dry extracts of *C.*

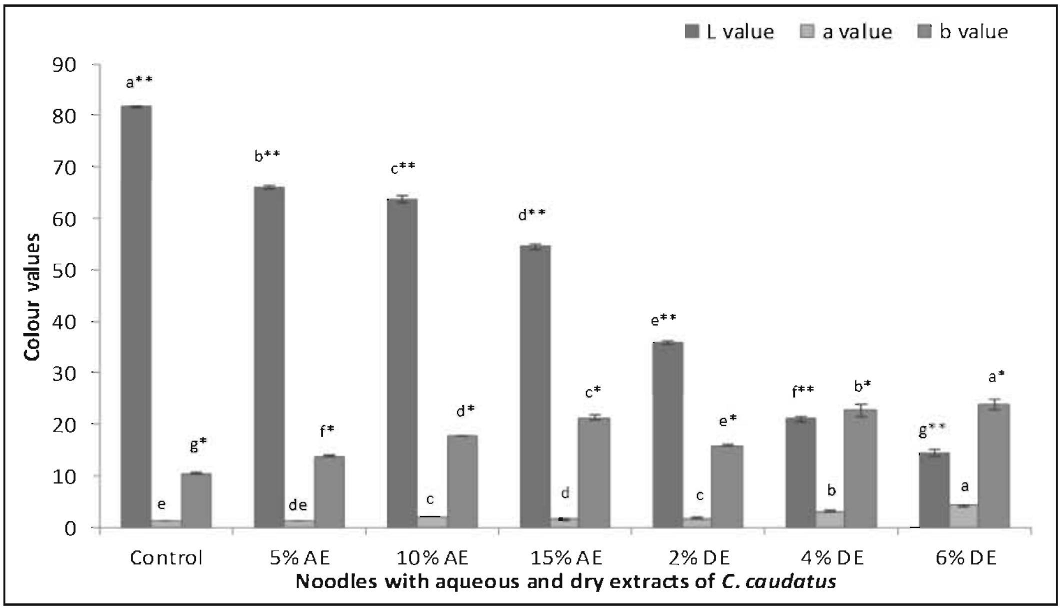

Figure 1. Colour parameters of different types of herbal yellow alkaline noodles prepared with aqueous extracts (AE) and dry extracts (DE) of *Cosmos caudatus*. Error bars indicate the mean values ± standard deviation of three replicates. Values with different lowercase letters are significantly different at $p < 0.05$.

caudatus. Yellowness (b*) showed a gradual increase among the samples. Visually, most of the noodles resulted in more brightness compared to yellowness characteristic, but noodles prepared with 4 and 6% dry extracts were the only exception. In fact, many studies have confirmed that there is a relationship between the use of alkaline salts that changes the pH levels and the colour of the alkaline noodles (Asenstorfer *et al.*, 2006; Hatcher *et al.*, 2009). It has been reported that the yellowish colour associated with alkaline noodles is due to the presence of flavonoid pigments in flour, which are colourless at acidic pH levels but turn to a yellowish tone at alkaline pH. High amounts of a* value in noodles made with dry extracts was due to the presence of colouring components of *C. caudatus.* Auto-oxidation of endogenous phenolic compounds contained in *C. caudatus* or the actions of enzymes caused the darker colour of the dry extract noodles as compared to other noodles (Gan *et al.*, 2009).

Antioxidant properties

Total phenolic content

Results of the study showed that the phenolic compound of all the noodles tested varied from 115.16 to 149.18 mg GAE/100g. Generally, TPC of 5, 10 and 15% aqueous extract noodles did not show significant difference among the groups (132.84, 134.85 and 137.14 mgGAE/100g) but the amounts were higher than in the control noodle (Figure 2). Similarly, noodles that were added with 6% dry extract contained the highest amount of TPC i.e. 149.18 mgGAE/100g ($p < 0.05$). Non-significant differences ($p > 0.05$) were observed amongst control, 2 and 4% dry extracts; however, higher TPC in the 6% dry extract noodles can be due to the presence of higher amounts of *C. caudatus*. In this regard, Choo & Aziz (2010) also noted the same behaviour for noodles with 30% banana flour. Previous studies regarding the TPC of selected tropical Malaysian plants showed that the methanolic extract

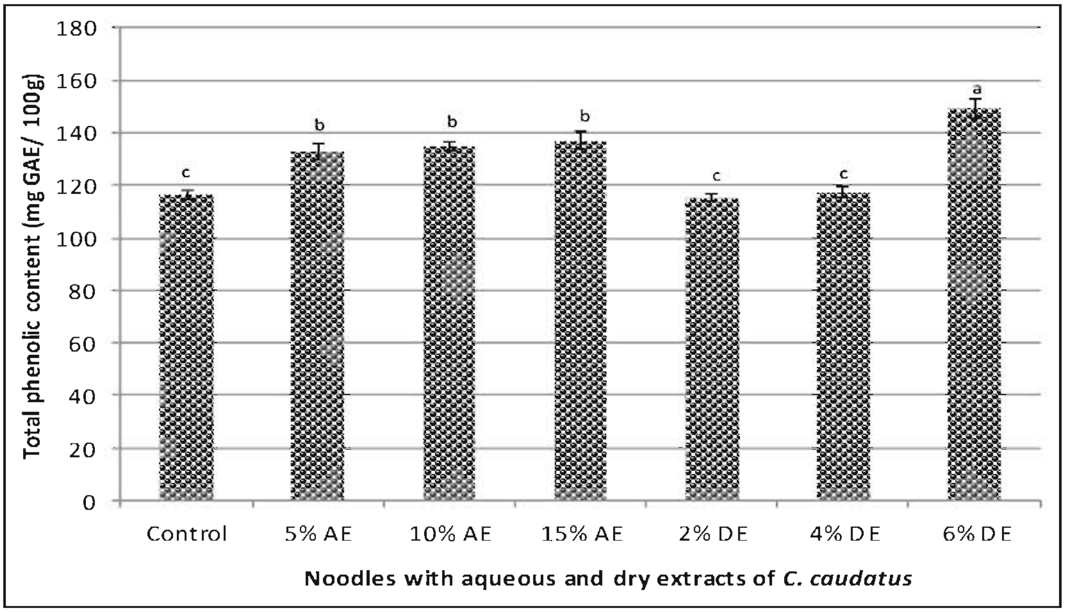

Figure 2. Total phenolic content of herbal yellow alkaline noodles prepared with aqueous extracts (AE) and dry extracts (DE) of *Cosmos caudatus*. Error bars indicate the mean values ± standard deviation of three replicates. Values with different lowercase letters are significantly different at $p < 0.05$.

of *C. caudatus* contain higher TPC, that is, 704.21 mgGAE/g (Mustafa *et al.*, 2010). Huda, Ruzita & Aronal (2010) reported that the aqueous extract of *C. caudatus* yielded the lowest extraction value (1.93%). On the other hand, Sulaiman *et al.* (2011) showed that extraction using distilled water and 70% ethanol gave low TPC values that were 0.3% and 1.7% mgGAE/dry weight basis, respectively. The findings of TPC values in *C. caudatus* herbal noodles seemed to be parallel with the findings of previous reports. Differences in TPC values might be due to differences in geographical locations, nature of harvested plant, and extraction procedures (Huda *et al.*, 2010).

DPPH free radicals scavenging assay

Di-phenyl picryl-hydrazine (DPPH) assay is useful for investigating *in vitro* free radical scavenging activities of plants/ compounds. In some earlier studies, *C. caudatus* had shown significant DPPH radical scavenging activities (Abas *et al.*, 2006; Huda *et al.*, 2010; Mustafa *et al.*, 2010; Sulaiman *et al.*, 2011). Scavenging activity increased with increasing concentration of *C. caudatus* extracts incorporated in the noodles. The maximum concentration of inhibition of radicals of the noodles was at 5000 ppm, and the percentage of inhibition observed in 4% dry extract noodles was 92.8%. In the present study, free radical scavenging capabilities of the herbal yellow alkaline noodles were also determined (concentration ranging from 50-5000 ppm). Herbal noodles with dry extracts exhibited higher radical scavenging activity com-pared to aqueous extract noodles and control (Table 2). As the concentration of the samples was increased, the percentage of inhibition of DPPH radical by scavenging effect of samples was also increased. It is evident from the results that more inhibition was recorded with increasing amounts of *C. caudatus* extract. Nearly all noodles exhibited potential for inhibiting free

Table 2. The DPPH free radicals scavenging activity of different types of herbal yellow alkaline noodles prepared with aqueous and dry extracts of *Cosmos caudatus*

Treatment	*DPPH radical scavenging activity (%)*					
	50 ppm	*100 ppm*	*150 ppm*	*1000 ppm*	*3000 ppm*	*5000 ppm*
Control	8.91 ±4.02e	11.56±0.15d	11.14 ± 2.09g	16.10± 0.81d	26.00±1.45f	30.06±0.41g
5% AE	13.96 ±5.34d	12.06±0.90d	15.56 ± 0.60f	18.00± 0.70d	20.70±0.26f	38.53±1.35f
10% AE	23.30 ±0.78ab	25.96±0.61b	29.56 ± 1.01c	32.86± 0.75c	35.56±1.04e	47.43±2.87e
15% AE	28.16 ±0.80a	29.50±1.30a	33.23 ± 1.81b	38.33± 1.02b	48.96±1.85c	57.63±0.32c
2% DE	17.33 ±0.76cd	22.60±1.66c	26.50 ± 1.00d	33.00± 2.08c	40.83±2.65d	53.53±0.90d
4% DE	19.43 ±0.76cb	24.73±1.60b	24.20 ± 0.36e	57.93± 0.80a	71.00±1.73b	92.76±2.48a
6% DE	22.56 ±3.00b	28.43±1.25a	38.70 ± 0.45a	59.20± 1.15a	75.26±0.76a	86.43±1.52b

AE = aqueous extract and DE = dry extract
* Control refers to yellow alkaline noodle without addition of the extract
** Each value in the table represents the mean ± standard deviation of triplicate measurements. Mean values with different lowercase letters within the same column are significantly different at $p < 0.05$.

radicals but significant differences were also observed. It was observed that 6% dry extract had the highest scavenging activity, from 38.7%, 59.2% and up to 75.3%. This finding indicates that the potential of using *C. caudatus* extract in dry form is better than in aqueous form based on the results of free radicals scavenging activity. Sulaiman *et al.* (2011) revealed that DPPH assays of fresh *C. caudatus* in aqueous extract was the lowest (0.9% mgGAE/dry weight basis) that is 19.4%, 19.6% and 23.2% compared with 70% acetone, 70% ethanol and 70% methanol, respectively. In another study conducted by Andarwulan *et al.* (2010), *C. caudatus* possessed the highest DPPH compared to other vegetables, and this is in agreement with Mustafa *et al.* (2010), that is, scavenging activity with IC50 of 21.31μg/ml compared to other plants. Later, Reihani & Azhar (2012) also enumerated that *C. caudatus* contains significantly higher antioxidant activities in the salad species available in Malaysia.

According to the authors' knowledge, limited studies on determination of DPPH radical scavenging activity in noodles or pasta are available in the literature. However, the results obtained in this study are predictable as *C. caudatus* possesses higher antioxidant properties that could impart health benefits upon consumption, especially due to the presence of phenolic compounds (Abas *et al.*, 2006; Wong *et al.*, 2006; Mustafa *et al.*, 2010).

Sensory appraisal of herbal yellow alkaline noodles

Sensory evaluation is important to assess consumer acceptability and marketability and it allows food manufacturers to develop new products or evaluate the existing food products based on consumer preference and eating quality. The mean scores on sensory acceptability of herbal noodles attributes using a hedonic scale is shown in Figure 3. The 15% aqueous extract was the most acceptable noodles perceived by all 50 panellists and showed a significant difference ($p < 0.05$) compared to others, while 6% dry extract noodle was the most unacceptable noodle. The degree of liking towards all noodle attributes studied was found to be higher in aqueous extract noodles than in noodles made with dry extracts. Results indicated that 5% aqueous extract noodles obtained the highest mean score for aroma. No significant difference

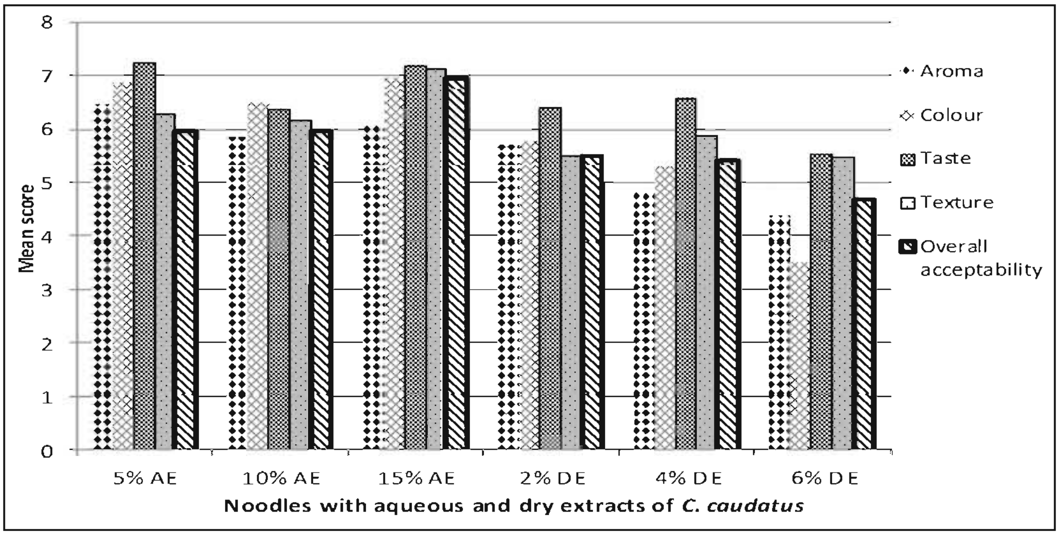

Figure 3. The mean scores on sensory acceptability of different types of herbal yellow alkaline noodles prepared with aqueous extracts (AE) and dry extracts (DE) of *Cosmos caudatus* using a hedonic scale. Mean score of 5 is the cut-off point indicating that the product is neither liked nor disliked.

(p> 0.05) was observed in terms of colour acceptability among wet extract noodles (p< 0.05). Although, the mean scores for the taste of noodles with 5 and 15% aqueous extracts were acceptable, it was significantly less than the control. Overall, noodles prepared with the addition of 15% aqueous extract received the highest sensory scores in terms of texture and taste attributes, and overall acceptability.

Herbal noodles are not new since there are many herbal noodles available in the market, such as spinach, basil and seaweed noodles. However, the noodles containing the Ulam Raja or *C. caudatus* K. are not available in the market. In the present sensory study, 20 persons out of a total of 50 panellists were willing to purchase these noodles if it was made available in the market, while 27 of them would consider buying it, but the remaining three panellists refused to accept the product. Hence, the herbal noodles developed in the present study can become a functional food of choice for consumers as people are willing to buy healthy products due to awareness of health and wellness for a healthy lifestyle.

CONCLUSION

Herbal yellow alkaline noodles were developed successfully using different concentrations of aqueous and dry extracts of *C. caudatus*. Addition of extracts significantly contributed to higher antioxidant activities based on the result of TPC and DPPH. Generally, the noodles prepared with aqueous extract were more acceptable by the panellists compared to dry extract noodles. The sensory panellists perceived the 15% wet extract noodle as the most acceptable whilst 6% dry extract noodle was the most unacceptable noodle. The findings from the sensory evaluation study indicate that there is a potential for the new herbal yellow alkaline noodle to be successfully distributed to society. However, pharmacological effects should be studied before using such noodles to reduce the risk of ailments.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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