ALEXANDRIA

SCIENCE EXCHANGE JOURNAL

VOL. 39 JANUARY- MARCH 2018

Effects of Turmeric Addition on Chemical Composition, Antioxidant Activity and Sensory Evaluation of Lentil Soup

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ABSTRACT

The objectives of the present study were to evaluate the chemical, sensory and antioxidant activity of lentil soup made with the addition of different levels of turmeric powder. The crude protein was 21.6% in lentil, whilst it was 3.18% in turmeric. Analyses revealed that turmeric contains higher amounts of both total phenolic (119.04 mg GAE/g) and flavonoids (9.61 mg RE/g) and had higher antioxidant activity followed by lentil soup compared with lentil seed. The increasing of addition level of turmeric powder in lentil soup significantly increased viscosity, yellow colors, and significantly decreased lightness. Moreover, the addition of turmeric powder significantly affects appearance, flavor, taste, texture attributes and overall acceptability of the resultant soups. In Conclusion, turmeric powder could be incorporated to lentil soup formulation up 2 g /100 g lentil to improve its quality attributes without causing any sensorial defect.

Key words: Lentil, Turmeric, Lentil soup, Phenolics, Flavonoids, Viscosity, Color.

INTRODUCTION

Lentil (*Lens culnaris Medik.*) is cultivated for its nutrient seed, which is one of the most important protein rich legumes. Lentil is an excellent source of protein and essential amino acids except methionine and cysteine (Bhatty 1988). It is a dietary mainstay and one of the most important legumes in the drier regions of the Middle East, North Africa, and Indian subcontinent (Yadav *et al.,* 2007). Lentils both in de-hulled and whole forms can be used in the form of flours and may be used to fortify some products like pasta, baby food and other cereal diets (Bhattacharya, 2005, and Sandhu & Singh, 2007). In Egypt, lentil is used in a wide variety of dishes like soups and koshary; a commonly served dish in Egypt, lentil soup also is a common dish in Egypt due to ease of preparation, desirable taste and high nutritional value. It is seasoned before serving with garlic, onion, black pepper and other spices.

Turmeric (*Curcuma longa* L.) is an herbaceous perennial plant of the ginger family, *Zingiberaceae*. It is a yellow-colored rhizome known for its use in different medicinal preparations, it is used as a curative, spice, food preservative, flavoring and coloring agent. It is one of the most folk spices containing natural phytonutrients. Due to its notable pharmacological effects, it is widely used in traditional and modern medicine for preparation of antimicrobial, anti-inflammatory, anti-venom, anti-protozoal, antiviral, anti-tumor, anti-Alzheimer and anti-mutagenic drugs (Sasikumar, 2001, Tilak *et al.,* 2004, and Valizadeh *et al.* 2016).

The objectives of this study were to evaluate the physico–chemical, sensory and antioxidant activity of lentil soups made with different levels of turmeric powder.

MATERIALS AND METHODS

Materials:

Lentil, turmeric powder, salt, onion, garlic, cumin and black pepper were obtained from local market of Damanhour city, Egypt.

Methods:

Lentil soup preparation

Lentil seed was cleaned manually to remove foreign matters such as dust, dirt, chaff, immature and damage seeds. Lentil soup was prepared according to an unpublished survey of common traditional Egypt lentil soups. Turmeric powder addition levels were 0%, 1%, 2% and 3% of lentil seed weight. The recipes used in the preparation of lentil soups are given in Table 1. To prepare soups, all ingredients were blended in water, then the mixture was boiled for 10 min.

Determination of proximate chemical composition

The proximate composition of lentil seed and turmeric powder for moisture, crude protein, crude fat, crude ash and crude fiber were determined by approved methods 44-40, 46-11A, 30-10, 08- 01 and 32-07, respectively (AACC, 2000). The nitrogen conversion factor used for crude protein calculation was 6.25. N-

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Received Januury 04,2018, Accepted February 15, 2018

free extract content was calculated by subtracting the total contents of moisture, crude protein, crude fat, crude ash and crude fiber from 100.

Table 1. Lentil soup recipes with different levels of turmeric powder

Ingredients (g)	Control	T1	T2	T3
Lentil seeds	100	99	98	97
Turmeric powder	-	1	2	3
Water	900	900	900	900
Salt	3	3	3	3
Onion	1.5	1.5	1.5	1.5
Garlic	0.75	0.75	0.75	0.75
Cumin	0.35	0.35	0.35	0.35
Black paper	0.35	0.35	0.35	0.35

Control, T1, T2 and T3: lentil soups were made using turmeric powder in amounts of 0, 1,2 and 3 g, respectively.

Determination of total phenolic content

The total phenolic content was extracted and determined according to the Folin-Ciocalteu procedure (Zilic *et al.,* 2012). Briefly, the extract (100 µL) was transferred into a test tube and the volume was adjusted to 3.5 mL with distilled water and oxidized with the addition of 250 µL of Folin-Ciocalteau reagent. After 5 min, the mixture was neutralized with 1.25 mL of 20% aqueous sodium carbonate (Na_2CO_3) solution. After 40 min, the absorbance was measured using a spectrophotometer at 725 nm against the solvent blank. The total phenolic content was calculated by means of a calibration curve prepared using gallic acid and expressed as µg of gallic acid equivalent (mg GAE) per 100 g of sample.

Determination of flavonoid content:

The content of flavonoids in the examined sample extracts was determined using spectrophotometric method (Quettier *et al.,* 2000). The sample was extracted with aqueous methanol, then 1 ml of the methanolic solution was mixed with 1 ml of 2% $AlCl_3$ methanol solution. The contents were incubated for an hour at room temperature and the absorbance was determined using a spectrophotometer at 415 nm. A calibration curve using rutin as a standard was construed. Based on the measured absorbance, the concentration of flavonoids was recorded as rutin equivalent (mg of RE/g of sample).

Free radical scavenging capacity.

Free radical scavenging capacity was determined using the stable 1,1-Diphenyl-2-picryl-hydrazyl (DPPH) according to Hwang and Do-Thi (2014). The final concentration was 50 µM for DPPH and the final reaction volume was 3.0 ml. The absorbance at 517 nm was measured against a blank of pure methanol after 60 min. Percent inhibition of the DPPH free radical was calculated by the following equation:

Inhibition (%) = 100 × (Acontrol - Asample)/ Acontrol

Where: Acontrol is the absorbance of the control reaction (containing all reagents except the test compound).

A sample is the absorbance of the test compound. Also, the antioxidant activity was determined by means of a calibration curve prepared with Trolox, and expressed as mg of Trolox equivalent (TE) per gm of sample.

Viscosity measurement

Viscosity and shear rate of lentil soup samples were measured according to Brookfield manual (1998) using Brookfield Engineering labs DV-III Ultra Rheometer. The sample was placed in a small sample adapter and a constant temperature water bath was used to maintain the desired temperature. The viscometer was operated between 10 and 60 rpm. Viscosity and shear rate data were obtained directly from the instrument, the SC4-21 spindle was selected for the measurement. Rheological measurements were made on the resultant soup samples and controlled at room temperature (25˚C ± 1˚C).

Color measurements

The color of soup samples was measured using a spectrocolorimeter with the CIE color scale (Hunter, Lab scan XE). This instrument was standardized against the white tile of Hunter Lab color standard (LX No.16379): X= 77.26, Y= 81.94 and Z= 88.14. The L*, a* and b* values were reported. The Hunter L* (luminosity), a* (+, red, to -, green) and b* (+, yellow to -, blue) values were used for calculating the chroma (C) and hue angle (H) according to the following equations:

$$C = (a^2 + b^2)^{0.5} \quad (1)$$

$$H = \tan^{-1}(b/a) \quad (2)$$

$$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{0.5} \quad (3)$$

where ΔL = L sample – L standard, Δa = a sample – a standard, Δb = b sample – b standard

Sensory evaluation

Sensory evaluation for lentil soup was determined by 20 trained panels. The panels were provided with lentil soup samples and asked to evaluate their appearance, flavor, taste, texture, and overall acceptability. All samples were coded and presented in a randomized arrangement. Sensory assessment was analyzed using a nine-point hedonic:1 means extremely dislike, 5 means neither like nor dislike and 9 means extremely like.

Statistical analysis

Statistical analysis was performed according to SAS Institute (2017) using General Linear Model (GLM) with the main effect of addition levels. Duncan's multiple range was used to separate among of three replicates at $p < 0.05$.

RERSULTS AND DISCUSSION

Chemical composition of lentil and turmeric

Data in Table (2) show the chemical composition of lentil and turmeric. It was clear that the moisture content was very close in lentil seeds and turmeric where it represented 11.66% in lentil and 11.41%in turmeric. On the other hand, N-free extract was the highest constituent in both (57.49% in lentil and 78.73% in turmeric). The crude protein was 21.6% in lentil whilst it was 3.18% in turmeric. These results agree with (El-Nahry *et al.,* 1980). Who found that the protein content in lentil ranged between 22 – 25%. However, the crude fiber, total ash and the crude ether extract were the lowest constituents where they represented 4.38%, 2.8% and 2.07% in lentil and 2.94%, 2.12% and 1.62% in turmeric, respectively.

Table 2. Chemical composition of lentil seed and turmeric powder

Component	Lentil	Turmeric
Protein	21.60±0.41	3.18±0.38
Lipids	2.07±0.65	1.62± 0.23
Ash	2.80±0.11	2.12± 0.18
Crude fiber	4.38±0.41	2.94±0.29
N-free extract	57.49±0.35	78.73±0.31
Moisture	11.66±0.23	11.41± 0.15

All values are means of triplicate determinations ± standard deviation (SD).

Total phenolic, flavonoids and antioxidants activity.

Total phenolic, flavonoids and antioxidant activity using DPPH assay for lentil, turmeric and lentil soup containing turmeric are shown in Table (3). The turmeric contains the highest amounts of both total phenolic (119.04 mg GAE/g) and flavonoids (9.61 mg RE/g) in addition to its highest antioxidant activity followed by lentil soup compared with lentil seed. It was clear that addition of turmeric to lentil soups elevated their total phenolic, total flavonoids and antioxidant activity. Where there were significant differences ($p \leq 0.05$) between turmeric, lentil seed and lentil soup in all parameters under studies. These results are also broadly comparable to these previously published (Lin and Lai, 2006; Xu *et al*., 2007; Ren *et al*., 2012).

Viscosity of lentil soups

Viscosity is one of the most important property of liquid foods. Food can be classified depending on the relationship between viscosity and shear rate into Newtonian, non-Newtonian, dilatant, pseudo plastic, thixotropic and rheopectic. Such classification is known to be useful in quality control, processing, sensory evaluation (Fellows, 2000). In soup manufacturing, apparent viscosity is an index of thickness.

The relationship between the apparent viscosity values (cP) and shear rates (S^{-1}) of the lentil soups containing different amounts of turmeric powder is illustrated in Figure 1. The apparent viscosity of lentil soup samples decreased as shear rate increased. This observation means that the soup samples had a remarkable apparent viscosity pattern which can be described as a non-Newtonian pseudoplastic type. The control apparent viscosity pattern recorded the lowest values (200- 580 cP) compared to T1, T2 and T3. The increasing of the amount added turmeric significantly increased the apparent viscosity of resultant soup samples.

Color properties of lentils soup

Color is one of the most important quality attributes of food products. Color measurements of lentil soups are illustrated in Table (4).

Table 3. Total phenolic, total flavonoids and antioxidants activity of lentil seed, turmeric and lentil soups

Material	Lentil	Turmeric	Lentil soup			
			control	T1	T2	T3
Total phenolic (mg GAE/g)	6.52±0.34 ^{d}	119.04±1.67^{a}	7.59±0.64 ^{d}	9.38±0.71 ^{c}	9.84±0.66 ^{bc}	10.47±0.79 ^{b}
Flavonoids (mg RE/g)	1.81±0.36 ^{c}	9.61±0.24 ^{a}	1.92±1.32 ^{c}	2.28±0.52 ^{b}	2.33±0.37 ^{b}	2.39±0.17 ^{b}
Antioxidant Activity%	18.63±0.72 ^{c}	68.29±0.11^{a}	18.44±1.03 ^{c}	21.61±0.74 ^{b}	21.87±0.38 ^{b}	22.04±0.96 ^{b}

-All values are means of triplicate determinations ± standard deviation (SD).

- Different letters (a–d) in the same raw refer to significant differences at $p \leq 0.05$ levels between different samples. Letters (a–d) were used to compare mean for each other. a = highest content followed by b, c, etc.

- Control, T1, T2 and T3 mean Lentil soup containing 0, 1, 2 and 3 g turmeric powder/100 gm Lentil seeds, respectively

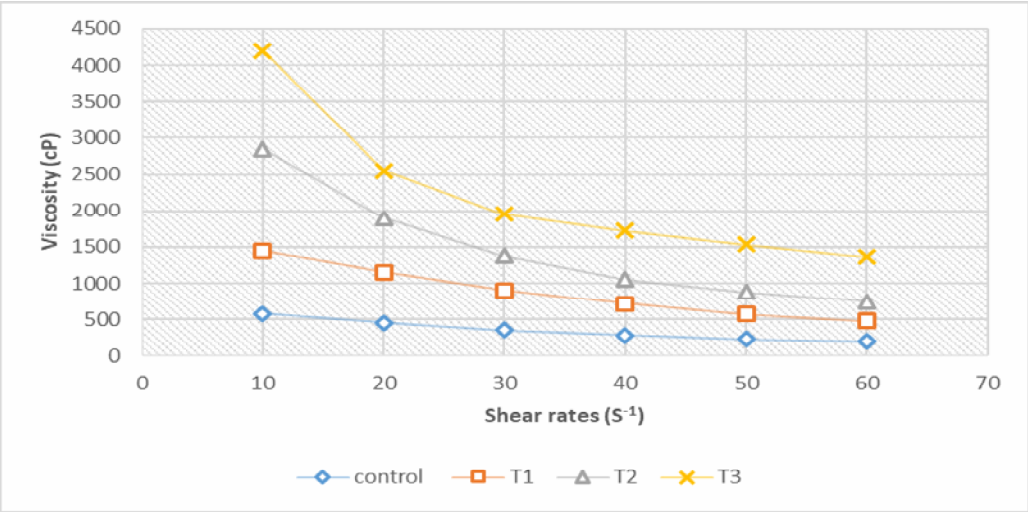

Figure 1. Viscosity of the lentil soup samples at different shearing rates

Data indicated that addition of turmeric powder significantly increased the lightness (L) values of lentil soups, however, increasing the added level of turmeric did not significantly affect this value. On contrary, the redness (a) values of lentil soups significantly decreased in T1, T2 and T3 compared to control. The increasing of adding level of turmeric significantly reduced (a) values. These results may be due to a decrease in the amounts of lentils in treatments T1, T2 and T3 compared to control. For yellowness (b) values, addition of turmeric significantly increased the yellowness of the lentil soups. This result is due to contribution the yellow color of turmeric powder. However, yellowness value, color saturation value (c) were found also to be increased with increasing of amount of turmeric powder added.

Theoretically, when total color difference value is 1 it is representing a just-noticeable color difference to the human eyes under ideal viewing conditions; while total color difference values between 2 and 3 could be considered equivalent by some viewers in less than ideal lighting (Vervoort *et al.,* 2012). From Table 4, total color difference values between control and T1 was 1.80±0.09, while it was higher than 3 between control and both of T2 and T3, suggesting that the color differences between these samples and the control are perceptible by human eyes under normal lighting conditions. However, there was a significant total color difference value between lentil soups containing turmeric, which confirming the sensory evaluation results for appearance.

Sensory evaluation of lentil soup:

The mean score of the panel evaluation for appearance, flavor, taste and texture of lentil soup samples containing different amount of turmeric powder are tabulated in Table (5).

The data indicate that the addition of turmeric powder significantly affects appearance, flavor, taste, texture attributes and overall acceptability of the resultant soups. T1 and T2 had markedly higher scores of all parameters than the T3 and control. The results showed that adding 3g of turmeric to lentil soup gave a good general acceptance by panelists in line with the control sample, but, the taste morally reduced compared to the other samples. This result may be attributed to that increasing the amount of turmeric to 3 g caused a bitter taste.

Table 4. Color properties of lentil soups

Samples	L*	a*	b*	Chroma	Hue	Total color difference (ΔE)
Control	82.11±0.07^{b}	6.25±0.06^{a}	33.31±0.05^{c}	33.89±0.04^{c}	79.37±0.05^{c}	0
T1	82.84±0.05^{a}	5.81±0.04^{b}	34.35±0.08^{b}	34.83±0.07^{b}	80.41±0.07^{b}	1.80±0.09^{c}
T2	83.05±0.04^{a}	5.66±0.02^{b}	34.77±0.03^{ab}	35.22±0.08^{a}	80.76±0.06^{b}	3.36±0.03^{b}
T3	83.26±0.03^{a}	5.13±0.06^{c}	35.04±0.06^{a}	35.41±0.04^{a}	81.65±0.07^{a}	5.56±0.09^{a}

Values are means ± standard deviation of triplicate determinations. Means with different letters within a raw are significantly different ($p \leq 0.05$). Control, T1, T2 and T3 mean Lentil soup containing 0, 1, 2 and 3 g turmeric powder/100 gm lentil seeds, respectively

Table 5. The sensory evaluation of lentil soups

sample	Appearance	Flavor	Taste	Texture	Overall acceptability
Control	7.68±0.16 ^{ab}	7.06±0.65 ^{b}	7.54±0.79^{b}	7.32±1.21^{b}	7.65±0.29 ^{b}
T1	8.87±0.94^{a}	7.98±1.37 ^{a}	8.02±1.09 ^{a}	8.24±1.74 ^{a}	8.11±1.23 ^{a}
T2	8.81±0.23^{a}	8.02±2.31^{a}	8.45±0.64 ^{a}	7.96±0.48 ^{ab}	8.12±0.36 ^{a}
T3	7.59±1.03 ^{b}	7.95±2.51^{a}	6.68±2.02 ^{c}	7.82±1.62 ^{ab}	7.39±1.06 ^{b}

Control, T1, T2 and T3 mean Lentil soup containing 0, 1, 2 and 3 g turmeric powder/100 Lentil seed, respectively. Values are means ± standard deviation of triplicate determinations. Means with different letters within a column are significantly different ($p \leq 0.05$).

CONCLUSION

The present study confirmed the high the nutritional value of lentil seed. Lentil seed is one of the most important foods consumed in Egypt, so it is necessary to increase its content of phenolic compound and flavonoids to increase its oxidative activity. This study showed that the addition of turmeric powder to lentil soups increased the amounts of both total phenolic (119.04 mg GAE/g) and flavonoids (9.61 mg RE/g), thereby increased their antioxidant activity. The increasing of addition level of turmeric powder in lentil soup significantly increased viscosity and yellow color, and significantly decreased lightness. Moreover, the addition of turmeric powder significantly affects appearance, flavor, taste, texture attributes and overall acceptability of the resultant soups. In Conclusion, turmeric powder could be preferably incorporated with lentil soup formulation up 2 g /100 g lentil seed to improve its quality attributes without causing any sensorial defect.

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الملخص العربي

تأثيرات إضافة الكركم على التركيب الكيميائي والخواص الحسية ونشاط تضادّ الأكسدة لحساء العدس

محمود عبد الجليل روزن، هالة محمود بيومي، إسماعيل جلال برعي

الهدف من الدراسة الحالية تقييم التركيب الكيماوي، ونشاط تضاد الأكسدة، وبعض الصفات الفيزوكيماوية، والتقبُّل الحسي لحساء العدس المعدّ بإضافة نسب مختلفة من مسحوق الكركم. وقد أظهرت النتائج أنَّ تركيز البروتين الخام في بذور العدس ٢١,٦٪، في حين بلغ ٣,١٨٪ في مسحوق الكركم. كما بيَّنت النتائج أن الكركم يحتوي على كميات أعلى من كل من الفينولات الكلية (١١٩,٠٤ ملجم حمض جاليك / جم)، والفلافونويدات (٩,٦١ ملجم روتين / جم)، كما كان نشاط تضاد الأكسدة الذي أظهره حساء العدس أعلى مقارنة ببذور العدس. وقد أظهرت الدراسة أنّ زيادة نسبة إضافة مسحوق الكركم في حساء العدس يسبب زيادة معنوية في اللزوجة ودرجة اللون الأصفر، وزيادة التقبل الحسيّ. وبصفة عامّة؛ فإنَّ إضافة مسحوق الكركم إلى حساء العدس حتى ٢جم/ ١٠٠ بذور عدس يرفع قيمته التغذوية، ويُحسّن تقبل المستهلكين له.

الكلمات الدالة: العدس، الكركم، حساء العدس، المواد الفينولية، الفلافونويدات، تضاد الأكسدة، اللزوجة، اللون.