

***Characterization of Cephalotyre (Ras) Cheese Supplemented with Turmeric Powder***

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***Abstract***

Cephalotyre (Ras) cheese supplemented with turmeric (*Curcuma longa* L.) powder was investigated for color, chemical, rheological and sensorial characteristics during ripening as an attempt to produce functional dairy product have the therapeutic effects of turmeric. Also, identification and quantification of turmeric phenolic compounds and antioxidant activity were investigated for the tested sample. The phenolic compounds profile of different turmeric extracts showed that the turmeric had the highest content of different phenolic compounds such as gallic acid, catechin, syringic acid, ellagic acid, coumaric acid, vanillin, ferulic acid, naringenin, and cinnamic acid. The addition of prepared turmeric powder in the Ras cheese processing increased the dry matter content gradually as the turmeric level increased. Also, the color factor increased as the turmeric level increased in comparison with control cheese. The addition of turmeric powder to Ras cheese increased their hardness while other texture characteristics were close to control cheese. The flavor and appearance of turmeric Ras cheese were slightly higher than control cheese except the highest level of turmeric. It could be concluded that the addition of prepared turmeric (*Curcuma longa* L.) powder to Cephalotyre (Ras) cheese as a natural color agent improved the chemical, physical, rheological and sensorial characteristics during ripening at the low level of 0.25% without any appeared defects during ripening period.

**Keywords:** Cephalotyre (Ras) cheese; Turmeric; Color agent; Ripening.

***Introduction***

Ras cheese is the most popular hard type cheese produced in Egypt which is similar to the Greek "Cephalotyre" cheese (**Abou-Donia, 2002**). Ras cheese is usually made from cows' milk or mixture of cows' and buffaloes' milk, it is ripened for at least three months at 12–15 °C and about 80% relative humidity (**El-Sayed et al., 1993**). Ras cheese produced in small industrial units located in the Delta region (**Phelan et al., 1993**). The popularity of Ras cheese is mainly due its unique taste and aroma (**El-Kholy, 2015**). Flavor is the most significant attribute for the consumer but color and appearance create the first impress and greatly influence on the acceptability of Ras cheese. Annatto

has been used for over two centuries as a food color especially in cheese and the various forms are now used in a wide range of food products. The food color annatto is obtained from the outer layer of the seeds of the tropical tree *Bixa orellana* L.

Turmeric (*Curcuma longa* L.) is a plant distributed throughout tropical and subtropical regions of the world. It is widely cultivated in Asian countries, mainly in China and India. Turmeric contains 69.4% carbohydrates, 6.3% protein, 5.1% fat, 5.8% essential oils, and 3-6% of curcuminoids (**Amalraj et al.,2017**). Turmeric is an essential spice all over the world with a distinguished human use particularly among the Eastern people (**Ravindran et al.,2007**). Apart from this using as spice, it is used as traditional medicine in Asian countries such as India, Bangladesh and Pakistan because of its beneficial properties (**Chattopadhyay et al.,2004**). It is called turmeric (Kurkom in Egypt while Zarchooveh in Iran) and has been in continuous use for its flavoring, and medicinal properties (**Govindarajan, 1980**). The coloring principle of turmeric is called curcumin, which has yellow color and is the essential component of this plant (**Ammon et al.,1992**).

Turmeric is highly regarded as a universal panacea in the herbal medicine with a wide spectrum of pharmacological activities. Current traditional medicine claims its powder against gastrointestinal diseases, especially for biliary and hepatic disorder, diabetic wounds, rheumatism, inflammation, sinusitis, anorexia, coryza and cough (**Ammonet al.,1992**). These medicinal properties of turmeric caused it to be considered as a spice with multifunctional medicinal properties.

Therefore, the aim of the present work was to examine the effect of turmeric powder on color, chemical, rheological and sensorial characteristics of Cephalytyre (Ras) cheese during ripening. Also, identification and quantification of turmeric phenolic compounds and antioxidant activity were investigated.

## **Materials and methods**

**Raw materials and chemicals:** Turmeric and curry were obtained from the herbal market, Cairo, Egypt. Fresh cow's and buffalo's milk were obtained from the herd at the Faculty of Agriculture, Cairo University, Egypt. Microbial rennet powder (RENIPLUS) extracted from *Mucormiehei* was purchased from Gaglio Star, Spain. Cheese starter culture used in the cheese manufacture mixture of *Lactococcuslactis* subsp. *lactis* and *Lactococcuslactis* subsp. *cremoris* was obtained from Egyptian Microbial Culture Collection (MIRCEN), Ain Shams University, Egypt. Gallic acid, 2,2-diphenyl-1-picrylhydrazyl (DPPH) and Folin-Ciocalteu phenol reagent were purchased from Sigma Aldrich, Germany. Other used chemicals were of analytical grade.

### **Methods**

**Preparation of turmeric extract:** Turmeric extract was prepared according to **Tanvir et al. (2017)** as follow: dried turmeric samples were cleaned and ground into a fine powder by laboratory mill. Finely powdered (10 %) dried turmeric (prepared) was extracted using methanol solvent in comparison of both commercial turmeric powder (Ready) and curry powder (Mixture). Extracts were stored at 5 °C for 24 h then filtrated through two layers of cheese cloth followed by centrifugation at 5000 rpm for 15 min at 5 °C. The supernatant of extracts were individually concentrated by rotary evaporator to dryness under reduced pressure.

**Total phenolic content (TPC) of turmeric:** TPC of turmeric extracts were determined colorimetrically using Folin-Ciocalteu reagent, in accordance with the modified method described by *Lafka et al. (2007)*. TPC was calculated by a calibration curve prepared with Gallic acid as a standard and expressed as mg gallic acid equivalent (GAE/ml).

**Antioxidant activity of turmeric:** The antioxidant activity of turmeric extracts were evaluated by using the stable 2,2-diphenyl-1-picryl-hydrazyl (DPPH) radical scavenging method according to *Matthuset al. (2002)*. The radical scavenging activities of the samples tested, which were expressed as a percentage inhibition of DPPH, were calculated according to the following formula:

$$\text{Inhibition (\%)} = [(A_{\text{control}} - A_{\text{sample}}) / A_{\text{control}}] \times 100$$

Where: A, the absorbance at 515 nm of the control sample; A<sub>0</sub>, the final absorbance of the test sample at 515 nm.

**Identification and quantification of turmeric phenolic compounds:** Phenolic compounds of methanolic turmeric extracts were identified and quantified by HPLC using an Agilent 1260 series. The separation was carried out using C18 column (4.6 mm x 250 mm i.d., 5 µm). The mobile phase consisted of water (A) and 0.02% tri-floro-acetic acid in acetonitrile (B) at a flow rate 1 ml/min. The mobile phase was programmed consecutively in a linear gradient as follows: 0 min (80% A); 0–5 min (80% A); 5–8 min (40% A); 8–12 min (50% A); 12–14 min (80% A) and 14–16 min (80% A). The multi-wavelength detector was monitored at 280 nm. The injection volume was 10 µl for each of the sample solutions. The column temperature was maintained at 35 °C. Phenolic compounds of each sample were identified by comparing their relative retention time with those of the standard mixture chromatogram. The concentration of an individual phenolic compound was calculated on the peak area measurements, then convert to µg phenolic compound per gram of turmeric.

**Ras cheese manufacture:** Ras cheese was made by the conventional method as described by *Hofiet al. (1970)*. Ras cheese was produced using mixture of cows' and buffaloes' milk; the milk mixture was divided into 4 portions. The first portion was colored with food grade annatto color and served as control (C); the other three portions was supplemented with prepared turmeric powder at the level of 0.25, 0.5, and 1.0 g/100 milk which served as T1, T2, and T3 respectively. Fresh Ras cheese samples and after 1, 2, and 3 months during ripening were taken for analysis.

**Ras cheese chemical analysis:** Ras cheese samples were chemically analyzed according to *AOAC (2000)* for total solids, fat, total protein, ash and soluble nitrogen contents. Acidity as a lactic acid was determined by the titration method with 1/9 N NaOH, according to *Ling (1963)*.

**Ras cheese color measurements:** Color of Ras cheese samples was measured using a Hunter colorimeter model D2s A-2 (*Hunter Assoc. Lab Inc., VA, USA*) following the instruction of the user manual Hunter colorimeter as described by *Hunter (1975)*.

**Textural profile analysis (TPA) of Ras cheese:** TPA were performed using a Universal Testing Machine (Co metech, B type, Taiwan) using 25-mm-diameter perplex conical-shaped probe, and then the generated plot of force (N) versus time (s) was recorded. TPA parameters were determined according to the definition given by the International Dairy Federation (IDF, 1991) from the resulting force-time curve for textural attributes such as hardness, chewiness, cohesiveness, gumminess and springiness were calculated.

**Organoleptic evaluation of Ras cheese:** The sensorial properties of the experimental cheese samples when fresh and after 1, 2, and 3 months during their ripening period at  $12 \pm 2$  °C was evaluated according to *Pappas et al. (1996)*. Cheese was assessed by 20 panelists from the staff of Dairy Science Department, National Research Centre, with a maximum score points of 50 points for flavor, body and texture (40 points) and 10 points for the cheese's appearance.

**Statistical analysis:** The results average values were analyzed by *SAS soft ware (SAS, 1999)*.using ANOVA procedure for analysis of variance. The results were expressed as mean  $\pm$  standard error and the differences between means were tested for significance using Duncan's multiple range at  $p \leq 0.05$ .

## Results and Discussion

### **Total phenolic content of turmeric extracts**

Plant phenolics are important constituents that contribute to functional quality, color, and flavor and have significant roles both as singlet oxygen quenchers and free radical scavengers, helping to minimize molecular damage (*Tanviret al., 2015*). TPC of prepared turmeric (4.74 mg GAE/100 g) is higher than the commercial turmeric (Ready) while the curry had the highest TPC value (Fig. 1). It could be due to the turmeric powder was prepared in the laboratory without any heat treatment which affects the phenolic compounds content compared to commercial form of turmeric, while the highest TPC of curry mainly due to it is a mixture of different herbals contains turmeric. These findings were lower than those mentioned by (*Qader,et al., 2011*) who indicated that TPC in turmeric ranged from 6.15% to 16.07% in ethanolic extracts; while higher than those mentioned by *Wojdyło et al. (2007)* who indicated that TPC in turmeric was 1.72 mg GAE/100 g.

However, the polyphenols content of turmeric as a spice was varied depends on genotypic, environmental differences namely (climate, location, temperature, fertility, diseases and pest exposure), choice of parts tested, time of taking samples, and determination methods (*Kim and Lee,2004; Shanet al.,2005*).

### **Identification of turmeric phenolic compounds**

The phenolic compounds profile of different turmeric extracts showed that the prepared turmeric had the highest content of different phenolic compounds such as gallic acid, catechin, syringic acid, ellagic acid, coumaric acid, vanillin, ferulic acid, naringenin, and cinnamic acid, in comparison of other turmeric extracts (Table 1). It is confirmed the TPC content and antioxidant activity of turmeric extracts as shown in Fig. 1, especially for the prepared turmeric sample. However, ferulic acid was shown to inhibit the photo-peroxidation of linoleic acid (*Wang, 2003*). Catechin and coumaric acid showed antioxidant activity (*Kimet al.,2004; Shanet al., 2005*). Approximately 235 compounds, primarily phenolics and terpenoids, have been identified from various species of turmeric. Also, calebin-A, vanillic acid, vanillin, quercetin, and other phenolic compounds have also previously been identified from turmeric (*Tanviret al.,2017; Mieanet al., 2001; Guptaet al., 2013*).

### **Antioxidant activity of turmeric extracts**

The health benefits of phenolics are primarily derived from their antioxidant potentials because the radicals produced after hydrogen or electron donation are resonance stabilized and thus relatively stable. To counter the potential hazards of oxidative damage, the dietary consumption of

antioxidant phenolics including phenolic acids and flavonoids may be regarded as the first line of defense against highly reactive toxicants (Denre, 2014).

Antioxidant activity of prepared turmeric is slightly higher than the commercial turmeric (Ready) (Fig. 1) which could be due to the TPC content (Table 1) of turmeric samples. Also, curry had the highest antioxidant activity among other turmeric samples as shown in Fig. 1, which might be due to TPC content of curry from different herbals other than turmeric. However, turmeric contains 2–9% curcuminoids (curcumin is the most abundant curcuminoid in turmeric), as well as its derivatives (bis-demethoxycurcumin and demethoxycurcumin) which have been shown to be a powerful scavenger of oxygen free radicals (Anand et al., 2008; Priyadarsini, 2014). Kim and Lee (2004), Chattopadhyay et al. (2004), and Shan et al. (2005) mentioned that many of phenolic compounds consider non-enzymatic antioxidant with radical-scavenging power such as catechins, flavonols (kaempferol), and phenolic acid (caffeic and coumaric acid).

Hence, some authors (Katsube et al., 2004; Katalinic et al., 2006) have demonstrated a linear correlation between the content of total phenolic compounds and their antioxidant capacity. Also, Wojdylo et al. (2007) reported that Polish species were rich in phenolic constituents and demonstrated good antioxidant activity measured by different methods.

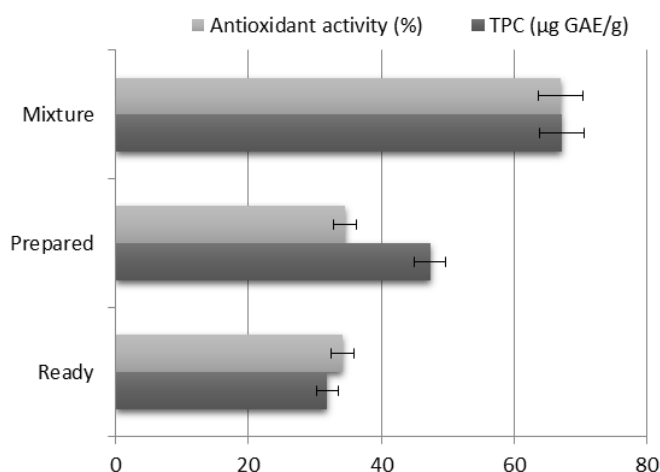


Fig. 1. Total phenolic compounds and antioxidant activity of turmeric.

**Prepared:** finely-powdered dried turmeric; **Ready:** commercial turmeric powder; **Mixture:** commercial curry powder.

#### Chemical characterization of Ras cheese

The addition of prepared turmeric powder in the Ras cheese processing increased the dry matter (DM) gradually as the turmeric level increased as shown in Table 2, without significant ( $p \leq 0.05$ ) differences. It could be due to the chemical composition of turmeric which contains 69.4% carbohydrates, 6.3% protein, 5.1% fat, 3.5% minerals, and 13.1% moisture (Amalraj et al., 2017; Nasri et al., 2014). These findings were in line with those reported by (Al-Obaidi, 2019). Also, it could be noted that DM content of all Ras cheese treatments increased throughout their ripening period which mainly due to the loss of moisture during ripening (Fahmy, 2003).

**Table 1**. Phenolic compounds content of turmeric (*C. longa*) indifferent form.

Phenolic compounds	Phenolic compounds content of turmeric extracts (µg/g)		
	Ready	Prepared	Mixture
Gallic acid	25.57	27.65	26.22
Chlorogenic acid	17.29	15.49	33.97
Catechin	13.27	13.37	7.29
Methyl gallate	0.60	0.90	5.80
Coffeic acid	3.35	5.08	62.05
Syringic acid	4.20	5.55	3.40
Pyro catechol	ND	ND	8.97
Rutin	ND	ND	40.96
Ellagic acid	27.97	43.93	8.20
Coumaric acid	7.15	11.11	8.58
Vanillin	12.52	19.00	4.49
Ferulic acid	16.69	22.60	5.49
Naringenin	0.97	11.36	2.76
Taxifolin	46.25	4.54	10.08
Cinnamic acid	12.10	19.37	11.85
Kaempferol	30.71	21.30	13.34

ND: Not detected.

Also, Table 2 showed that the protein and water-soluble nitrogen (WSN) as a ripening index for cheese as it reflects the extent of proteolysis of Ras cheese were increased as the turmeric level increased (*Sousa et al., 2001*). However, WSN in cheese is primarily formed by coagulating enzymes, plasmin or cell-wall envelope proteases at the early stage of proteolysis. It is well recognized that protein breakdown is an essential factor for equal flavors and texture change during the ripening period (*Youssef et al., 2019; El-Sayed et al., 2020*). Also, it could be noticed that protein and WSN contents of all Ras cheese treatments increased throughout their ripening period progressed which mainly due to the loss of moisture during ripening (*Fahmy, 2003*).

The fat content of turmeric Ras cheese samples was lower than control cheese, as well as their fat level was decreased as the turmeric level increased (**Table 2**). Also, it could be noticed from Table 2 that the ash content of turmeric Ras cheese treatments was higher than control cheese which can be attributed mainly to the minerals content of turmeric powder (*Nasri et al., 2014; Amalraj et al., 2017*).

As shown in Fig. 2, Ras cheese acidity of control Ras cheese was close to the lowest level of turmeric powder (0.25%, T1), as well as the acidity of Ras cheese (T2 and T3) were decreased as the turmeric level increased. Similar results were also noted by *Sousa et al. (2001)* who reported that herbal extracts with high phenolic contents in the cheese samples prevented the increase in the pH during storage. Also, it could be noticed that the acidity of all Ras cheese samples increased as their ripening period progressed which could be due to the production of acidic compounds as a result of fermentation of residual lactose and degradation of intermediates components of protein and fat (*Sousa et al., 2001; El-Hofi et al., 2010*).

**Color attributes of Ras cheese**

Table 3 shows that the color factor (b) which refer to yellow to blue colors was increased as the turmeric level increased in comparison with control cheese mainly due to the yellow color of turmeric. However, turmeric contains 3–4% curcumin which responsible for its yellow color (*Nasri et al., 2014*). Also, the yellow color of cheese with turmeric decreased (l) value and increased (a) value of colors (Table 3).

**Table 2**  
Chemical characterization of Ras cheese with turmeric (*C. longa*) powder during ripening.

Parameter (%)	Ripening period (month)	Turmeric powder addition (%)			
		C	T1	T2	T3
Dry matter	F	59.03±0.58 <sup>CD</sup>	58.57±0.58 <sup>D</sup>	61.62±0.58 <sup>hD</sup>	63.89±0.58 <sup>defCD</sup>
	1	61.42±0.58 <sup>hBC</sup>	62.61±0.58 <sup>ghBC</sup>	63.50±0.29 <sup>efgBC</sup>	64.07±0.58 <sup>cdefBC</sup>
	2	62.30±0.29 <sup>ghB</sup>	63.42±0.29 <sup>efgB</sup>	64.40±0.29 <sup>cdeB</sup>	65.50±0.29 <sup>bcB</sup>
	3	64.90±0.29 <sup>bcdeA</sup>	65.09±0.29 <sup>bcdA</sup>	66.33±0.58 <sup>abA</sup>	67.07±0.58 <sup>aA</sup>
Total protein	F	17.58±0.29 <sup>gC</sup>	19.29±0.35 <sup>defB</sup>	19.72±0.58 <sup>cdeA</sup>	20.58±0.29 <sup>abcdA</sup>
	1	18.10±0.29 <sup>fgBC</sup>	19.80±0.58 <sup>bcdAB</sup>	20.20±0.29 <sup>bcdeA</sup>	20.80±0.29 <sup>abcA</sup>
	2	18.85±0.58 <sup>efgABC</sup>	20.11±0.58 <sup>bcdAB</sup>	20.55±0.44 <sup>bcdeA</sup>	21.06±0.29 <sup>abA</sup>
	3	19.55±0.58 <sup>cdeA</sup>	20.72±0.58 <sup>abcdA</sup>	21.01±0.29 <sup>abA</sup>	21.72±0.29 <sup>aA</sup>
Total fat	F	36±0.29 <sup>abcdB</sup>	35±0.58 <sup>defB</sup>	33±0.58 <sup>hiC</sup>	32±0.29 <sup>iC</sup>
	1	36.5±0.29 <sup>abcA</sup>	35.75±0.58 <sup>bcdAB</sup>	34±0.58 <sup>ghBC</sup>	33.5±0.29 <sup>ghB</sup>
	2	37±0.29 <sup>abA</sup>	36.5±0.29 <sup>abcA</sup>	35±0.58 <sup>defAB</sup>	34.5±0.29 <sup>efgA</sup>
	3	37.25±0.29 <sup>abA</sup>	36.5±0.29 <sup>abcA</sup>	35.5±0.29 <sup>cdeA</sup>	35±0.01 <sup>defA</sup>
Ash	F	4.50±0.03 <sup>aA</sup>	4.55±0.03 <sup>aA</sup>	5.01±0.06 <sup>aA</sup>	5.24±0.06 <sup>aA</sup>
	1	4.61±0.06 <sup>aA</sup>	4.60±0.06 <sup>aA</sup>	5.14±0.06 <sup>aA</sup>	5.33±0.06 <sup>aA</sup>
	2	4.75±0.03 <sup>aA</sup>	4.81±0.01 <sup>aA</sup>	5.22±0.06 <sup>aA</sup>	5.42±0.06 <sup>aA</sup>
	3	4.80±0.01 <sup>aA</sup>	5.20±0.06 <sup>aA</sup>	5.31±0.06 <sup>aA</sup>	5.61±0.01 <sup>aA</sup>
Water soluble nitrogen	F	0.22±0.06 <sup>hC</sup>	0.38±0.03 <sup>ghC</sup>	0.40±0.01 <sup>fgC</sup>	0.52±0.58 <sup>cdefCD</sup>
	1	0.34±0.58 <sup>ghBC</sup>	0.42±0.01 <sup>fgBC</sup>	0.45±0.58 <sup>efgBC</sup>	0.60±0.58 <sup>bcdBC</sup>
	2	0.45±0.58 <sup>efgAB</sup>	0.50±0.58 <sup>defAB</sup>	0.52±0.01 <sup>cdefAB</sup>	0.71±0.01 <sup>bB</sup>
	3	0.60±0.29 <sup>bcdeA</sup>	0.61±0.29 <sup>bcdA</sup>	0.66±0.29 <sup>bca</sup>	0.87±0.29 <sup>aA</sup>

C, Ras cheese with annatto color; T1, Ras cheese supplemented with 0.25% of prepared turmeric powder; T2, Ras cheese supplemented with 0.50% of prepared turmeric powder; T3, Ras cheese supplemented with 1.0% of prepared turmeric powder. All parameters are represented as mean of replicates ± standard error. Means with different small superscript letters in the same row and different capital superscript letters in the same column are significantly different at  $p \leq 0.05$ .

**Rheological properties of Ras cheese**

The addition of turmeric powder to Ras cheese increased their hardness compared to control cheese. Other texture characteristics including springiness, cohesiveness, gumminess, and chewiness of turmeric Ras cheese (T1 and T2) were close to control cheese while the highest level of turmeric decreased such textual attributes in comparison of control cheese.

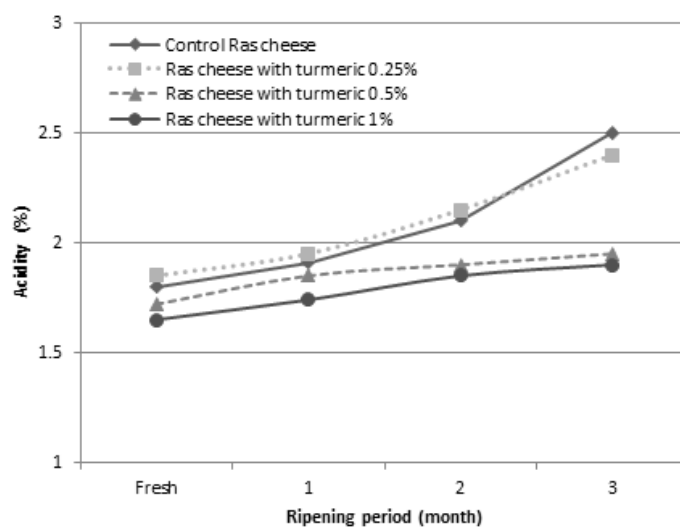


Fig. 2.

Acidity of Ras cheese with turmeric (*C. longa*) powder during ripening.

Table 3.

Color attributes of Ras cheese with turmeric (*C. longa*) powder.

Cheese treatments	Storage period (month)	Color parameter		
		L*	a*	b*
C	Fresh	85.27	3.88	22.08
	Three	80.34	7.02	31.35
T1	Fresh	90.86	7.88	58.66
	Three	87.60	7.41	68.62
T2	Fresh	85.73	1.70	65.02
	Three	76.71	5.96	79.50
T3	Fresh	74.44	8.09	81.75
	Three	75.18	7.51	80.68

C, Ras cheese with annatto color; T1, Ras cheese supplemented with 0.25% of prepared turmeric powder; T2, Ras cheese supplemented with 0.50% of prepared turmeric powder; T3, Ras cheese supplemented with 1.0% of prepared turmeric powder.

L\* value represents darkness from black (0) to white (100). a\* value represents color ranging from red (+) to green (-). b\* value represents yellow (+) to blue.



Table 4

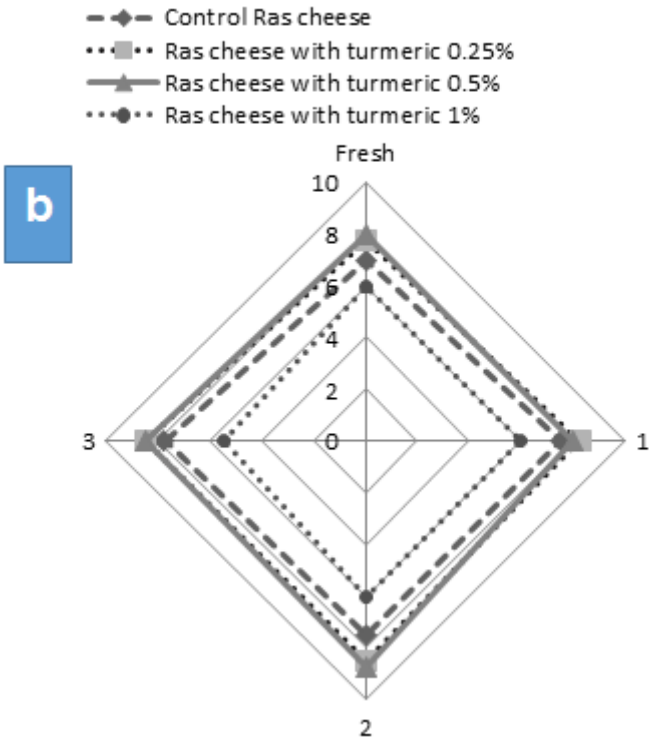
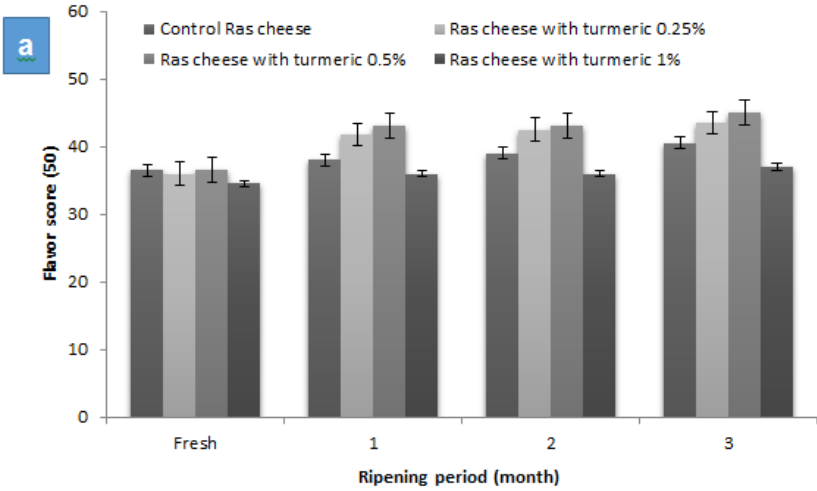
Texture profile analysis of Ras cheese with turmeric (*C. longa*) powder.

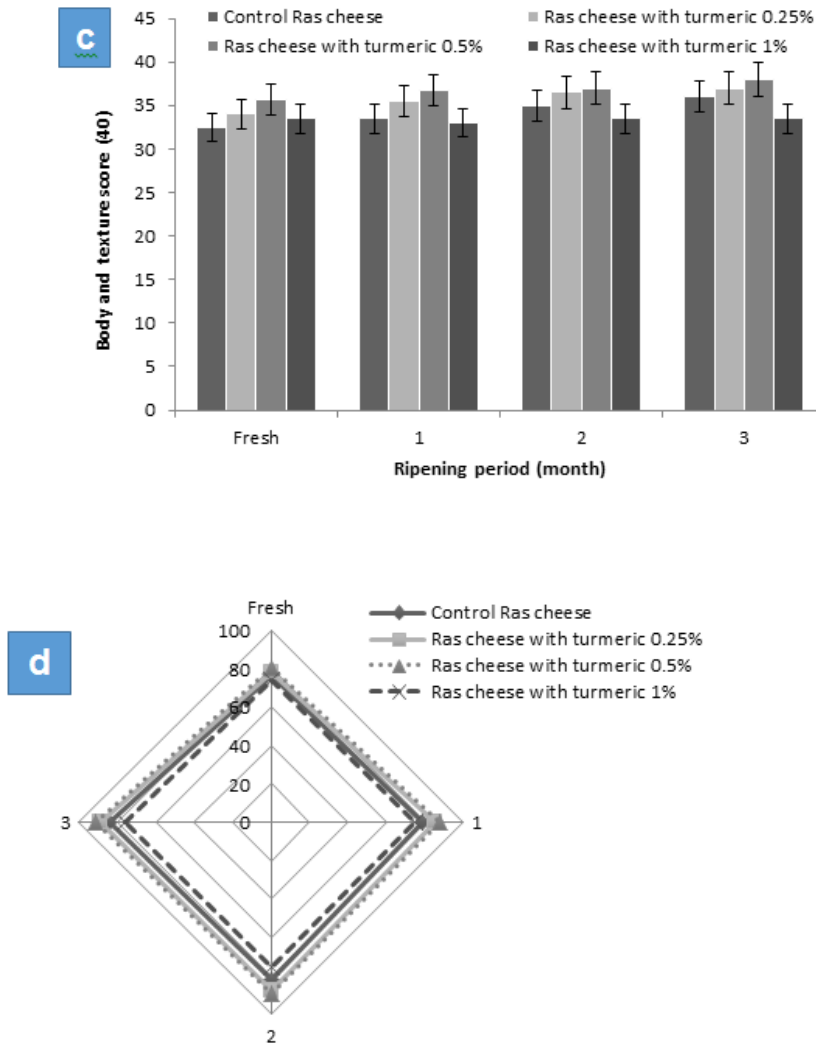
Parameter	Storage period (month)	Cheese treatments			
		C	T1	T2	T3
Hardness (N)	Fresh	8.60	9.42	10.58	10.92
	Three	13.72	14.42	16.30	25.37
Springiness (mm)	Fresh	0.789	0.937	0.788	0.605
	Three	0.809	0.607	0.807	0.638
Cohesiveness (Ratio)	Fresh	0.366	0.323	0.270	0.158
	Three	0.320	0.133	0.754	0.306
Gumminess (N)	Fresh	1.43	4.59	2.29	1.45
	Three	42.79	21.98	18.95	35.01
Chewiness (N.mm)	Fresh	1.13	4.30	1.80	0.88
	Three	34.62	13.34	15.29	22.34

C, Ras cheese with annatto color; T1, Ras cheese supplemented with 0.25% of prepared turmeric powder; T2, Ras cheese supplemented with 0.50% of prepared turmeric powder; T3, Ras cheese supplemented with 1.0% of prepared turmeric powder. N, newton; mm, millimeter; N.mm, newton millimeter. All parameters are represented as mean of replicates  $\pm$  standard error. Means with different small superscript letters in the same row and different capital superscript letters in the same column are significantly different at  $p \leq 0.05$ .

#### Sensorial characteristics of Ras cheese

Flavor (Fig. 3a) and appearance (Fig. 3b) of turmeric Ras cheese were slightly higher than control cheese, while the highest level of turmeric decreased both flavor and appearance attributes of cheese. Similar findings were also mentioned by **Al-Obaidi (2019)** who reported that the highest level of turmeric powder had a negative effect on the cheese flavor. Also, the addition of turmeric improved the texture of Ras cheese treatments expect the highest level of turmeric (Fig. 3c). Hence, the sensorial property reflects that the overall acceptability was increased as the turmeric level increased up to 0.5% (Fig. 3d). However, **Hosny et al. (2011)** reported that Karish cheese with turmeric had the highest flavor score without any changed during cold storage compared to control cheese.





**Fig. 3.**

Sensory evaluation of Ras cheese with turmeric (*C. longa*) powder during ripening. **a:** flavor score; **b:** appearance score; **c:** body and texture score; **d:** overall acceptability.

### Conclusion

It could be concluded that the addition of prepared turmeric (*Curcuma longa* L.) powder to Cephalotyre (Ras) cheese as a natural color agent improved the chemical, physical, rheological and sensorial characteristics during ripening at the low level of 0.25%. Further studies will be done for nutritional evaluation of the resulted Cephalotyre (Ras) cheese as a functional product especially for cardiovascular protection.

**Conflicts of interest:** The authors declare no conflict of interest.

Ethics approval: The present study has been carried out according to the Medical Research Ethics Committee, National Research Centre, Cairo, Egypt (**Registration No. 20-236**).

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## خصائص الجبن الراس (الرومي) المدعم بمسحوق الكركم

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### الملخص العربي

يهدف البحث لدراسة تأثير مسحوق الكركم كملون طبيعي للجبن الراس (المعروف بالجبن الرومي في السوق المصري) وكذلك دراسة التغيرات الكيميائية، الريولوجية والخواص الحسية أثناء فترة تسويه الجبن وذلك لإنتاج منتج لبنى وظيفي. كذلك، تم التقدير الكمي للمركبات الفينولية وتقدير النشاط المضاد للأكسدة لمسحوق الكركم المحضر معملياً بالمقارنة بالكركم التجاري والكارى. أظهرت النتائج إحتواء الكركم المحضر معملياً على أعلى محتوى من المركبات الفينولية المختلفة مثل gallic acid, catechin, syringic acid, ellagic acid, coumaric acid, vanillin, ferulic acid, naringenin, and cinnamic acid والتي أدت الى زيادة محتوى الكركم من المركبات الفينولية الكلية وكذلك النشاط المضاد للأكسدة مقارنة بمستخلصات الكركم الأخرى. أيضاً، أظهرت النتائج أن إضافة مسحوق الكركم المحضر معملياً إلى الجبن الراس أدت الى زيادة محتوى الجبن من المادة الجافة تدريجياً مع زيادة نسبة الكركم المضافة، كذلك زاد عامل اللون (b) مع زيادة مستوى الكركم مقارنة بالجبن الطبيعية. كذلك أدت إضافة مسحوق الكركم إلى زيادة صلابة قوام الجبن الراس بينما كانت خصائص القوام الأخرى قريبة من الجبن المقارنة. أما التقييم الحسى للجبن أظهر زيادة درجات تقييم كل من النكهة والمظهر العام للجبن المضاف اليه مسحوق الكركم بالمقارنة بالجبن الطبيعية باستثناء أعلى مستوى إضافة من الكركم.

ومن هنا نستنتج أن إضافة مسحوق الكركم المطحون معملياً بدون إستخدام الحرارة العالية كمادة ملونة طبيعية بنسبة 0.25% للجبن الراس قد أظهرت تحسن ملحوظ في كل من الخصائص الكيميائية والحسية للجبن الناتج بدون ظهور عيوب في المنتج خلال فترة التسوية. ولذلك سيتم دراسة تأثير الجبن الراس كمنتج وظيفي يحتوى على الكركم في حماية القلب والأوعية الدموية من خلال تجربة بيولوجية مناسبة.