Asian Journal of Agriculture and Food Sciences (ISSN: 2321 – 1571)
Volume 05 – Issue 01, February 2017

Microbiological Quality of Set Yoghurt Supplemented with Turmeric Powder (*Curcuma longa*) During Storage

Siham A. Rahmatalla[1,*], Lena Abd Alazeem[2], and Mohamed Osman Mohamed Abdalla[3]

[1]Department of Dairy Production, Faculty of Animal Production, University of Khartoum, Shambat P.O.Box 32, Postal Code 13314, Khartoum North, Sudan

[2]Department of Dairy Production, Faculty of Animal Production, University of Khartoum, Shambat P.O.Box 32, Postal Code 13314, Khartoum North, Sudan

[3]Department of Dairy Production, Faculty of Animal Production, University of Khartoum, Shambat P.O.Box 32, Postal Code 13314, Khartoum North, Sudan

[*]*Corresponding author's email: Sihamerwa76 [AT] yahoo.com*

ABSTRACT— ***This study was carried out to assess the effect of supplementing set yoghurt made from cow's milk with different concentrations of turmeric powder [T0 (0%), T1 (0.25%), T2 (0.50%) and T3 (0.75%)] on microbiological characteristics during the storage period. The results showed that supplementation of yoghurt with 0.75% (w/w) resulted in the reduction in total viable bacteria (log 5.42 cfu/gm), lactobacilli bacteria (log 5.11 cfu/gm) and yeasts and moulds (log 0.66 cfu/gm) counts, while coliform bacteria were not detected at this concentration. During the storage period all microorganisms under study increased to a maximum count at day 8 (log 6.67 cfu/gm, log 6.45 cfu/gm and log 1.62 cfu/gm for total viable bacteria, lactobacilli bacteria and coliform bacteria, respectively), while yeasts and moulds count gradually increased as the storage period progressed. Coliform bacteria and yeasts and moulds were not detected till day 5th of the storage period. The study concluded that, yoghurt samples supplemented with 0.75% turmeric powder secured the best microbiological profile in this study.***

Keywords— Yoghurt, turmeric concentration, microbiological, storage period

1. INTRODUCTION

Food spoilage is an enormous economic problem worldwide. Through microbial activity alone, approximately one-fourth of the world's food supply is lost. Undesirable microbes that can cause spoilage of dairy products include Gram-negative psychrotrophs, coliforms, lactic acid bacteria, yeasts and molds. In addition, various bacteria of public health concern such as *Salmonella* spp., *Listeria monocytogenes*, *Campylobacter jejuni*, *Yersinia enterocolitica*, pathogenic strains of *Escherichia coli* and enterotoxigenic strains of *Staphylococcus aureus* may also be found in milk and dairy products [1 2].

Milk is a highly unstable food as it is a very good medium for the growth of many microorganisms. Preservation of milk by fermentation aims at converting it into more stable nutritious and desirable products such as yoghurt, cheese and butter milk [3].

Yoghurt is a traditional fermented milk product produced through the fermentation of pasteurized milk by *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* [4]. It is a popular food in various parts of the world and has increased in popularity during the last decade, and its nutritional benefits and storage characteristics have led to its increasing economic importance [5].

Yoghurt shelf life is based on whether the products display any of the physical, chemical, microbiological or sensory characteristics that are unacceptable for consumption. Studies of changes in the quality characteristics during storage would be instrumental in predicting the shelf life of the product [6].

Turmeric (*Curcuma longa L.*) is a rhizomatous herbaceous perennial plant of the *ginger family*, (Zingiberacea), originated in tropical South Asia but is now widely cultivated in the tropical and subtropical regions of the world [7]. It has a short stem with large oblong rhizomes, which are often branched and brownish yellow in colour [8]. The spice turmeric, which is driven from the root of the plant *Curcuma longa*, has been described as a treatment of diabetes in a yurvedic and traditional medicine [9]. Curcumin is the most explored of the so called curcuminoids, a family of chemo-preventive

substances present in the spice, which increasingly being mentioned in health journals and scientific papers as research on it grows [10-12].

Various experiments proved the presence of bioactive compounds from curcuma and show that it has antimicrobial, anti-inflammatory, anticancer and antiviral activities, and may help to ease digestive discomfort, reduce inflammation and increase resistance to disease [12 13].

Turmeric has been used as a natural preservative in the food industry; therefore, this study was conducted to evaluate the effectiveness of turmeric against microorganisms in yoghurt.

2. MATERIALS AND METHODS

2.1 Source of materials

Fresh raw cow's milk was obtained from University of Khartoum dairy farm and transported in ice box at ≤10°C to the dairy processing laboratory, Department of Dairy Production, Faculty of Animal Production, University of Khartoum. Turmeric powder and plastic cups were purchased from the local market. The starter culture was obtained from Chr-Hansen Company, Denmark.

2.2 Manufacture of yoghurt

The milk was stirred and heated at 90ºC for 5 min, followed by cooling to 42ºC, and inoculated with 3% (w/w) starter culture (1:1 *Lactobacillus delbrueckii* ssp. *bulgarius* and *Streptococcus salivarius* ssp. *thermophilus*). Milk was divided into four equal portions and the turmeric powder was added at the rate of 0.25% (T1), 0.50% (T2), and 0.75% (T3) in addition to plain yoghurt without turmeric as a control (T0). The experiment was carried out in triplicate. The inoculated milk was incubated at 45ºC for 4 hr until a uniform coagulant was obtained. Yoghurt was then stored at 5ºC and microbiological examination was carried out at 1, 5, 8 and 12-day intervals.

2.3 Microbial examination of milk and yoghurt

For the determination of microbial viable counts of milk and yoghurt samples, appropriate dilutions of the respective sample in 1 ml aliquots were surface plated on prepared plates of nutrient agar for total viable bacteria count, MRS agar for lactobacilli count, MacConkey agar for the enumeration of coliform bacteria count [14-16], and potato dextrose agar (PDA) for yeasts and moulds count [17]. The plates, with exception to PDA, were incubated for at 32°C 48 hr, while PDA plates were incubated at 25°C for 72 hr. Characteristic colonies appearing on the respective selective agar media were counted and multiplied by the reciprocal of the dilution factor and expressed as colony forming units per milliliter (CFU/ml). Preliminary logarithm transformation of the data was required to guarantee an independence and normal distribution.

2.4 Statistical analysis

The data obtained from the microbiological examination were subjected to analysis using Statistical Analysis Systems (SAS, ver. 9). General linear models (GLM) procedure was used to determine the effect of turmeric powder concentration and storage period and their interaction on the microbiological characteristics of yoghurt. Mean separation was carried out by Duncan multiple range rest ($P \leq 0.05$).

3. RESULTS

The microbiological examination of raw milk revealed that total viable bacteria count was log 5.78 cfu/ml, while coliform bacteria, lactobacilli bacteria and yeasts and mould were not detected.

3.1 Total viable bacteria

Turmeric powder concentration significantly ($P<0.001$) affected total viable bacteria count with the count decreasing from log 7.91 cfu/gm in the control sample to log 5.42 cfu/gm in yoghurt supplemented with 0.75% turmeric (Table 1). Total viable bacteria count significantly ($P<0.001$) increased to log 6.67 cfu/gm at day 8 of storage period (Table 2). The highest total viable bacteria count was in the control sample at day 8 (log 8.57 cfu/gm) and decreased as the concentration of curcumin and storage period increased (Table 3).

3.2 Coliform bacteria

Coliform bacteria significantly ($P<0.001$) decreased in number as the concentration of turmeric increased, and were not detected when 0.75% concentration was used (Table 1). During the storage period, coliform bacteria were not detected at days 1 and 5, and increased in number (log 1.62 cfu/gm) at day 8 followed by a decrease at the end of storage period (Table 2). Coliform bacteria were not detected at the beginning of the storage period (days 1 and 5) in the control sample as well as yoghurt manufactured with different turmeric concentrations, and from day 8 the count increased in the control and decreased in all other treatments (Table 3).

3.3 Lactobacilli bacteria

The highest lactobacilli count (log 6.97 cfu/gm) was reported in the control, while the lowest count (log 5.11 cfu/gm) was in yoghurt supplemented with 0.75% turmeric (Table 1). Lactobacilli count significantly ($P<.001$) increased at day 8 (log 6.45 cfu/gm) and decreased to log 5.70 cfu/gm towards the end (Table 2). The count decreased in all treatments during

the storage period, with the highest count (log 6.72 cfu/gm) being in the control sample at day 12, and the lowest count (log 4.88 cfu/gm) being in yoghurt supplemented with 0.75% turmeric at day 1 (Table 3).

3.4 Yeasts and moulds

Yeasts and moulds count showed a significant ($P<0.001$) increase (log 1.39 cfu/gm) in yoghurt supplemented with 0.50% turmeric (Table 1). Yeasts and moulds were not detected at the beginning of the storage period (days 1 and 5), after which the number increased to log 3.37 cfu/gm at the end (Table 2). In the control sample as well as other treatments yeasts and moulds were not detected till day 8, and then they were detected at day 12 in numbers ranging from log 2.66 cfu/gm in yoghurt supplemented with 0.75% turmeric to log 3.82 cfu/gm in the control (Table 3).

4. DISCUSSION

Turmeric powder concentration significantly affected the microbiological species under study. The count of all microbes decreased as the concentration increased with the most destructive concentration being 0.75% (w/w). The lower number of microorganisms obtained in yoghurt supplemented with turmeric may be attributed to curcumin which is a natural polyphenol present in turmeric (*Curcuma longa*). Helen et al. [18] reported pharmacological activities of oil extracted from the members of the family Zingiberaceae, which exhibit antiallergic, antimicrobial, anti-inflammatory, antihyperlipidaemic, anti-nociceptive, anti-psychiatric, antioxidant, hepatoprotective and immunomodulatory and cytotoxic activities. Curcumin (diferuoyl methane), a yellow pigment is a phenilic compound and a major phytochemical constituent of Curcuma species, has been linked with suppression of inflammation angiogenesis, tumorigenesis, diabetes, diseases of cardiovascular, pulmonary and neurological systems of skin and liver, loss of bone and muscle, depression, chronic fatigue and neuropathic pain [10]. *Curcuma longa* was found to exhibit an antimicrobial activity against *Salmonella typhi, Xanthomonas campestis* and *Candida albicans* [13], *Streptococcus mutans* and *Streptococcus pyogenes* [19] and *Listeria monocytogenes* [20]. The antimicrobial activity of oil extracted from *Curcuma xanthorrhiza* could be attributed to the broad spectrum of bioactive chemical compounds [18].

Curcumin extract exhibits potent growth inhibitory effect against Gram positive bacteria (*S. aureus* and *Streptococcus mutans*), Gram negative bacteria (*E. coli* and *Pseudomonas aeruginosa*) and pathogenic yeast *Candida albicans* [8 21]. Helen et al. [18] reported that the essential oil extract from *Curcuma zanthorrhiza* rhizome showed remarkable antibacterial activity with zone of inhibition of 14 mm each against *E. coli* and *Bacillus amyloliguefaciens*, followed by *Klebsiella pneumonia*, *Shigella sonnie* and *Enterobacter aerogens*.

Yasodamma et al. [22] reported that *Bacillus subtilis, S. aureus, Pseudomonas aeruginosa* and *E. coli* were susceptible to leaf and rhizome extract of *Curcuma neilogherrensis*, with *S. aureus* being more susceptible followed by *P. aeruginosa*, *B. subtilis* and *E. coli*. Effective inhibition was observed against all selected strains with the leaf and rhizome extracts in order of alcohol>methanol>hot water>cold water>hydroalcoholic extracts, respectively.

Salmonella typhimurium was not detected after 5 days of storage in yoghurt with no *Curcuma cyminum* essential oil and yoghurt with 100 pp EO, and it was concluded that yoghurt samples had inhibitory effects on *S. typhymurium*, a result which might be significant for post-contamination of the infectious dose of *S. typhimurium* that might be very low. The results suggest that *S. typhimurium* populations were not inhibited by low concentrations of EO after 72 hr, while increase in EO concentration lead to decrease in bacterial counts [1].

5. CONCLUSION

Based on the results of this study, the addition of turmeric powder significantly affected the microbiological quality of yoghurt. The concentration of 0.75% (w/w) turmeric powder affected the total viable bacteria and lactobacilli bacteria, while coliform bacteria were not detected.

6. REFERENCES

[1] Mahmoudi R, Improvement the hygienic quality and organoleptic properties of bioyoghurt using *Cuminum cyminum L,* essential oil Journal of Agroalimentary Processes and Technologies,vol. 19, no.4, pp.405-412, 2013.

[2]. Varga L, Microbiological quality of commercial dairy products Communicating Current Research and Educational Topics and Trends in Applied Microbiology A. Méndez-Vilas (Ed.),pp. 487-94, 2007.

[3]. Dzigbordi B, Adubofuor J, Faustina Dufie W-M, The effects of different concentrations of natamycin and the point of addition on some physicochemical and microbial properties of vanilla-flavoured yoghurt under refrigerated condition, International Food Research Journal, vol. 20, no. 6, pp. 3287-3292, 2013.

[4] Tamime AY, Robinson RK, Yoghurt: Science and Technology. 3rd ed. , Cambridge, Woodhead Publishing Limited, pp. 808, 2007.

[5] Mohamed SHS, Zaky WM, Kassem JM, Abbas HM, Salem MME, Ahl HAHS-A, Impact of Antimicrobial Properties of Some Essential Oils on Cheese Yoghurt Quality, World Applied Sciences Journal, vol. 27, no. 4, pp. 497-507, 2013.

[6] Salvador A, Fiszman SM. Textural and sensory characteristics of whole and skimmed flavored set-type yogurt during long storage, J Dairy Sci., vol. 87, no. 12, pp. 4033-4041, 2004.
[7] Jurenka JS, Anti-inflammatory properties of curcumin, a major constituent of Curcuma longa: a review of preclinical and clinical research, Altern Med Rev., vol. 14, no. 2, pp. 141-53, 2009.
[8] Chattopadhyay s, KB, UB, padhyay, and, Banerjee RK, Turmeric and curcumin: biological actions and medicinal applications, Current science, vol. 87, no. 1, pp. 44-53, 2004.
[9] Aggarwal B, Shishodia S, Molecular targets of dietary agents for prevention and therapy of cancer, Biochem Pharmacol, vol. 71, no. 10, pp. 1397-1421, 2006.
[10] Anand P, Thomas SG, Kunnumakkara AB, Sundaram C, Harikumar KB, Sung B, Tharakan ST, Misra K, Priyadarsini IK, Rajasekharan KN, Aggarwal BB, Biological activities of curcumin and its analogues (Congeners) made by man and Mother Nature, Biochem Pharmacol, vol. 76, no. 11, pp. 1590-1611, 2008.
[11]. Chen YR, Tan TH, Inhibition of the c-Jun N-terminal kinase (JNK) signaling pathway by curcumin, Oncogene, vol. 17, no. 2, pp.173-178, 1998.
[12] Han KH, Azuma S, Fukushima M, In vitro fermentation of spent turmeric powder with a mixed culture of pig faecal bacteria, Food Funct, vol. 5, no. 10, pp. 2446-2452, 2014.
[13] Helen PM, Prinitha JSS, SM MA, Jacob A, Phytochemical characterization and Antimicrobial activity of oil and solvent extracts of Curcuma longa, Research Journal of Pharmaceutical, Biological and Chemical Sciences, vol. 3, no. 4, pp. 49-55, 2012.
[14] Christen L, Davidson P, McAllister J, Roth L, Coliform and Other Indicator Bacteria, In: Standard Methods for the Microbiological Examination of Dairy Products, *1*6th Edn., Ed., R.T. Marshal. Washington, DC: American Public Health Association, pp. 247-269, 1992.
[15] Harrigan WF. Laboratory Methods in Food Microbiology 3rd ed, Academic Press, London UK, pp. 202-245, 1998.
[16] Houghtby AG, Maturin LJ, Koenig KE, Microbiological Count Methods, In Standard Methods for the Microbiological Examination of Dairy Products, 16th edition. Ed., R.T, Marshal. Washington, DC: American Public Health Association, pp. 13-246, 1992.
[17] Frank FJ, Christen LG, Bullerman LB, Tests for groups of microorganisms, In Standard Methods for the Microbiological Examination of Dairy Products, 16th edition. Ed., *R.T.* Marshal. Washington, DC: American Public Health Association, pp. 271-286, 1992.
[18] Helen PM, Susheela GK, Jayasree S, Nizzy AM, Rajagopal B, Jeeva S, Phytochemical characterization and antimicrobial activity of Curcuma xanthorrhiza Roxb, Asian Pacific Journal of Tropical Biomedicine, vol. 2, no. 2, pp. 637-640, 2012.
[19] Mohammed NA, Habil NY, Evaluation of antimicrobial activity of Curcumin against two oral bacteria Automation, Control and Intelligent Systems, vol. 3, no. 2-1, pp.18-21, 2015.
[20] Antunes SA, Robazza WdS, Schittler L, Gomes GdA, Synergistic and antimicrobial properties of commercial turmeric (*Curcuma longa*) essential oil against pathogenic bacteria, Food Science and Technology (Campinas), vol. 32, pp. 525-530, 2012.
[21] Shahi SK, Shukla AC, Bajaj AK, Banerjee U, Rimek D, Midgely G, Dikshit, A, Broad spectrum herbal therapy against superficial fungal infections, Skin Pharmacol Appl Skin Physiol, vol. 13, no. 1, pp. 60-64, 2000.
[22] Yasodamma N, D.Chaithra, C.Alekhya, Antibacterial activity 0f Curcuma neilgherrensis WT. A Wild Curcuma Species, International Journal of Pharmacy and Pharmaceutical Sciences, vol. 5, no. 3, pp. 571-576, 2013.

Table 1. The effects of addition of turmeric powder on microbiological quality (log cfu/gm) of yoghurt supplemented with turmeric

Parameters	Turmeric powder concentration (%)				SE	SL
	Control	0.25	0.50	0.75		
Total viable bacteria count	7.91^{a}	6.47^{b}	5.74^{c}	5.42^{d}	0.003	***
Lactobacilli bacteria count	6.97^{a}	6.09^{b}	5.66^{c}	5.11^{d}	0.002	***
Coliform bacteria count	1.44^{a}	1.37^{a}	0.20^{b}	0.00^{b}	0.037	***
Yeasts and moulds count	0.95^{ab}	0.88^{ab}	1.39^{a}	0.66^{b}	0.064	***

Means in each row bearing similar superscripts are not significantly different (P>0.05)
*** = P<0.001
SE = Standard error of means
SL = Significance level

Table 2. Effect of storage period on the microbial quality (log cfu/gm) of yoghurt Supplemented with turmeric

Parameters	Storage period (days)				SE	SL
	1	5	8	12		
Total viable bacteria count	6.03^{c}	6.41^{b}	6.67^{a}	6.42^{b}	0.003	***
Lactobacilli bacteria count	6.34^{c}	6.02^{b}	6.45^{a}	5.70^{c}	0.002	***
Coliform bacteria count	0.00^{b}	0.00^{b}	1.62^{a}	1.41^{a}	0.037	***
Yeasts and moulds count	0.00^{c}	0.00^{c}	0.52^{b}	3.37^{a}	0.064	***

Means in each row bearing similar superscripts are not significantly different (P>0.05)
*** = P<0.001
SE = Standard error of means
SL = Significance level

Table 3. The microbial quality (log cfu/ml) of yoghurt supplemented with different concentrations of turmeric during the storage period

Parameters	Storage period (days)	Treatments (%)			
		Control	0.25	0.50	0.75
Total viable bacteria count	**1**	7.58	5.90	5.69	4.96
	5	7.90	6.50	5.87	5.39
	8	8.57	6.82	5.84	5.48
	12	7.61	6.65	5.55[i]	5.85
Coliform bacteria count	**1**	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.00	0.00
	8	2.84	2.80	0.83	0.00
	12	2.94	2.70	0.00	0.00
Lactobacilli bacteria count	**1**	6.35	5.84	5.59	4.88
	5	6.88	5.94	5.81	5.44
	8	7.92	6.70	5.84	5.35
	12	6.72	5.88	5.43	4.79
Yeasts and moulds count	**1**	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.00	0.00
	8	0.00	2.10	0.00	0.00
	12	3.82	3.55	3.46	2.66