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Effect of black pepper extract on sensory attributes and shelf life of paneer

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Abstract
Paneer is a tempting, nutritious and delicious acid- heat coagulated indigenous dairy product. Due to high moisture content (about 55%), it has shelf life of only one day at room temperature and up to a week at refrigeration temperature. Hurdles like spices, smoking, packaging etc. can be used to enhance shelf life of paneer. Black pepper is an important spice widely used in the world. It gives characteristic flavour to food products. It has a number of functional properties including: analgesic and antipyretic properties, antioxidant effects and antimicrobial properties. Black pepper extract, prepared by extraction of black pepper @ of 0.6, 0.7 and 0.8% by weight of milk, was incorporated into milk from which paneer was prepared. Paneer was prepared using the milk as per standardised method. It was observed that paneer incorporated with black pepper extract @ 0.7 % waand selected for further analysis. Colour, body and texture and overall acceptability scores of treated sams acceptable ple were lower than of control. While flavour scores of treated paneer were higher than those of control. Shelf life of control and black pepper paneer were only one day at ambient temperature. While shelf life of control and black pepper paneer were 8 and 12 days at refrigeration temperature, respectively. It was found that black pepper improved flavour and increase shelf life of paneer a refrigeration temperature.

Keywords: Paneer, black pepper, shelf life, sensory, storage study

Introduction
India is the largest producer of milk in the world. About 5% of milk produced in India is converted into paneer (Chandan *et al.*, 2007) [4]. Paneer is an important, acid-coagulated indigenous milk product extensively used as a cooking ingredient along with vegetables. Good quality paneer is characterized by a marble white color, sweetish, mildly acidic taste, nutty flavor, spongy body and closely knit, smooth texture. Paneer has a fairly high level of fat (22-25%) and protein (16-18%) and a low level of lactose (2.0-2.7%) (Kanawjia and Singh, 1996) [9]. Because of its high moisture content (about 55%), paneer has a shelf life of not more than one day at room temperature and up to a week at refrigeration temperature (Bhattacharya *et al.*, 1971) [3]. Hurdles like spices, humectants, smoking, microwave, packaging etc. can be used to enhance shelf life of paneer. Spices have been well known for their medicinal, preservative and antioxidant properties (Souza *et al.*, 2005) [20]. They are currently used mainly for enhancing the flavor of foods rather than extending shelf life (Almeida and Regitano, 2000) [1]. In addition to imparting flavor, certain spices prolong the shelf life of foods due to their bacteriostatic or bactericidal activity, and some prevent rancidity by their antioxidant activity (Shelef *et al.*, 1984) [19]. Many plant essential oils of spices are active against various food borne bacteria and moulds (Aureli *et al.*, 1992) [2]. Spices in general show antimicrobial activity due to phenolic component (Deans *et al.*, 1995) [6]. The ability of phenolics to interfere with cellular metabolism through a number of mechanisms (substrate complexing, membrane disruption, enzyme inactivation and metal chelation) is well known (Cowan *et al.*, 1999) [5]. Among the spices, black pepper is known as the king. It has extensive uses for flavoring and preserving processed foods and is also important medicinally. The quality of pepper is contributed by two components: Piperine (contributes the pungency) and volatile oil (responsible for the aroma and flavor) (Narayanan, 2000) [17]. Sasidharan and Menon (2010) [18] published analytical data on the chemical composition of pepper and the anti-microbial activity of the pepper oil. More than 80 components have been reported in pepper essential oil (Narayanan, 2000; Menon and Padmakumari, 2005; Sasidharan and Menon, 2010) [17, 13, 18]. Present study was conducted to investigate the effect of black pepper on sensory attributes and shelf life of paneer.

Materials and methods

Preparation of paneer

Paneer was prepared by a standardized method (Bhattacharya *et al.*, 1971) [3]. Fresh toned milk was procured from Experimental Dairy Plant of Southern Regional Station of ICAR- National Dairy Research Institute, Bengaluru. Milk was heated to 90 °C without holding and cooled to 80 °C and was coagulated with by adding 1 percent citric acid (2 g/litre of mik) solution at 80 °C. Acid was slowly added to the milk with continuous slow stirring until the curd and clear slightly yellow-greenish whey separated out. The mixture was then allowed to settle down for 5 minutes and whey was drained out through using muslin cloth. Pressing of curd was done with the weight of 35-40 g/cm^2 for 15-20 minutes into muslin cloth lined perforated wooden cubical hoop. Finally prepared paneer sample was kept in cold water at 5-7 °C for 2 hours. The chilled paneer removed from water and placed on a wooden plank for 10-15 min to drain occluded water and cut into 1cm cubes for further studies.

Spice extract preparation

Required quantity of ground black pepper (@ 0.6%, 0.7% & 0.8% by weight of milk) was weighed and taken into a beaker. Water (about 3 times weight of spice) was added to the spice and kept at room temperature for 12 hours. This soaked spice was again ground in a grinder and filtered through muslin cloth. This filtrate was added to milk during boiling of milk.

Black pepper paneer preparation

In the preparation of spice paneer, same procedure was followed as given above.

Sensory evaluation

Nine-point Hedonic scale method (Lawless and Heymann, 2010) [12] was used for sensory evaluation of all the samples by a panel of 7 semi trained judges. The samples were coded to preserve the identity of the samples presented to the judges. The samples were evaluated for color and appearance, body and texture, flavor and overall acceptability on the Hedonic scale ranging from 1 to 9 and the preferences were recorded in the sensory performa provided to the panelists.

Shelf life

Water activity of paneer was decreased to reduce the growth of spoilage microbes for enhancing the shelf-life. Paneer was packed in packaging material (polystyrene cups), stored at ambient temperature (30±1 °C) and refrigeration temperature (7±1 °C). Samples were taken out at regular interval for evaluating sensory and textural quality.

Analytical methods

SPC and yeast-mold counts of the paneer were estimated as per the method of ISI (1981a) [8].

Statistical analysis

Data of sensory analysis obtained in the study were subjected to statistical analysis by one way ANOVA using MS-Excel package version 2007.The differences among treatments were measured at 5% level of significance.

Result and discussion

Effect of black pepper extract on sensory quality of paneer

Black pepper extract, extracted from black pepper @ 0.6%, 0.7% and 0.8% by weight of milk, was incorporated into paneer. The black pepper incorporated paneer was subjected to sensory evaluation by judges. After sensory analysis, it was found that paneer incorporated with black pepper extract at 0.7 % got maximum flavor score (Table-1). So, 0.7% black pepper incorporated paneer was chosen for further studies.

Table 1: Effect of incorporation of black pepper extract on sensory score of paneer

Sensory attribute	Color and appearance	Body and texture	Flavor	Overall acceptability
Control paneer	8.06±0.05^a	7.81±0.10^a	7.63±0.12^a	8.00±0.10^a
0.6% black pepper	7.35±0.15^b	7.61±0.12^a	7.73±0.10^a	7.86±0.20^{ab}
0.7% black pepper	7.16±0.15^{bc}	7.48±0.10^a	7.81±0.13^a	7.53±0.07^b
0.8% black pepper	7.00±0.10^c	6.50±0.20^b	6.93±0.15^b	6.78±0.10^c

Color and appearance scores of black pepper paneer were significantly lower ($p \leq 0.05$) than control paneer due to changed color of paneer from white to slightly dark. Dark color in paneer may be due to color imparted by black pepper extract. On incorporation of 0.7% black pepper extract, color and appearance score decreased ($p \leq 0.05$) from 8.06 for control to 7.16 for black pepper paneer (Table-1). Body and texture score decreased ($p \leq 0.05$) from 7.81 for control to 7.48 for black pepper paneer. Reduction in body and texture score of black pepper paneer may be because of softer paneer formed as a result of incorporation of the pepper extract. Spice particles because of their granular nature may interfere in development of body and texture of the paneer (Eresam *et al.*, 2015) [7]. Flavor score of paneer increased from 7.63 for control paneer to 7.81 for black pepper paneer, which may be due to black pepper flavor. The overall acceptability scores also decreased ($p \leq 0.05$) from 8.00 for control to 7.53 for black pepper paneer, which may be due reduction of color and soft body of black pepper paneer (Table-1).

Changes in sensory quality of black pepper paneer during storage

Sensory analysis of control and black pepper paneer during storage at ambient temperature (30±1°C) and refrigeration temperature (7±1°C), were done by 7 judges for evaluating sensory characteristics like for color and appearance, body and texture, flavor and overall acceptability.

Color and appearance

Color and appearance score of control and black pepper paneer during storage are given in Table-2 and 3, which showed that scores significantly decreased during storage ($p \leq 0.05$) at ambient and refrigeration temperature. Score of control and black pepper paneer decreased from 8.03 to 5.60 and from 7.16 to 5.72 respectively, in two days storage at ambient temperature (Table-2). Color and appearance of control and black pepper sample became yellowish on surface due to slime production on second day. During storage at refrigeration temperature, score of control on 12th day and

black pepper paneer on 14th day decreased from 8.03 to 6.21 and from 7.16 to 6.61, respectively (Table-3). Dry surface appearance was observed in both samples during storage at refrigeration temperature. Darkness of black pepper paneer increased during storage at refrigeration temperature. Mishra *et al*. (2016) [15] also reported that color and appearance of paneer decreased during storage at ambient and refrigeration temperature.

Body and texture

Body and texture scores of control and black pepper paneer during storage are presented in Table-2 and 3, which showed that scores significantly decreased during storage ($p \leq 0.05$) at ambient temperature and refrigeration temperature. Score of control and black pepper paneer decreased from 7.88 to 5.87 and from 7.48 to 5.93 respectively, in two days storage at

Table 2: Effect of incorporation of black pepper extract on sensory score of paneer during storage at 30±1°C

Sensory attribute	Type of paneer	Storage period (days)		
		0	1	2
Color and appearance	Control paneer	8.03 ± 0.05^{aA}	7.50 ± 0.15^{bA}	5.60 ± 0.12^{cA}
	Black pepper paneer	7.16 ± 0.15^{aB}	6.67 ± 0.15^{bB}	5.72 ± 0.07^{cA}
Body and texture	Control paneer	7.88 ± 0.12^{aA}	7.23 ± 0.10^{bA}	5.87 ± 0.17^{cA}
	Black pepper paneer	7.48 ± 0.10^{aB}	7.05 ± 0.20^{bA}	5.93 ± 0.15^{cA}
Flavor	Control paneer	7.63 ± 0.10^{aA}	7.13 ± 0.10^{bA}	5.10 ± 0.15^{cA}
	Black pepper paneer	7.81 ± 0.05^{aB}	7.35 ± 0.10^{bB}	5.43 ± 0.20^{cA}
Overall acceptability	Control paneer	7.98 ± 0.10^{aA}	7.40 ± 0.15^{bA}	5.63 ± 0.22^{cA}
	Black pepper paneer	7.53 ± 0.07^{aB}	7.10 ± 0.12^{bB}	5.71 ± 0.15^{cA}

Note: Values with a different superscript (a, b) in a row or column (A,B between control and treated) are significantly different at $P<0.05$

Ambient temperature (Table-2). Body of control and black pepper paneer became soft and sticky; probability may be due to slime production by microbes. While during storage at refrigeration temperature, score of control in 12 days and black pepper paneer in 14 days decreased from 7.88 to 6.93 and from 7.48 to 6.73 respectively. Body and texture score of both the samples decreased due to hardening of paneer. It may be due to slight evaporation of moisture from paneer (Table-3). Mishra *et al.* (2017) [14] also reported that Body and texture of paneer decreased during storage at ambient and refrigeration temperature.

Flavor

Flavor score of control and black pepper paneer during storage are given in Table-2 and 3, which showed that scores significantly decreased during storage ($p \leq 0.05$) at ambient temperature and refrigeration temperature. Score of control and black pepper paneer decreased from 7.63 to 5.10 and from 7.81 to 5.43 respectively, in two days storage at ambient temperature (Table-2). At refrigeration temperature, score of control in 12 days and black pepper paneer in 14 days decreased from 7.63 to 5.15 and from 7.81 to 5.28 respectively (Table-3). At refrigeration temperature spoilage occurred due to flavor defect; in which paneer gave bitter taste due to proteolysis. Off flavor in stored *paneer* during storage at refrigeration temperature was also observed by Bhattacharya (1971) [3].

Table 3: Effect of incorporation of black pepper extract on sensory score of paneer during storage at 7±1°C

Sensory attribute	Type of paneer	Storage period (days)				
		0	4	8	12	14
Color and appearance	Control paneer	8.03 ± 0.05^{aA}	7.88 ± 0.12^{abA}	7.65 ± 0.17^{bA}	6.21 ± 0.10^{cA}	-
	Black pepper paneer	7.16 ± 0.15^{aB}	7.06 ± 0.11^{aB}	6.88 ± 0.10^{abB}	6.85 ± 0.15^{abB}	6.61 ± 0.10^{b}
Body and texture	Control paneer	7.88 ± 0.13^{aA}	7.45 ± 0.15^{bA}	7.06 ± 0.16^{cA}	6.93 ± 0.15^{cA}	-
	Black pepper paneer	7.48 ± 0.10^{aB}	7.21 ± 0.10^{abA}	6.96 ± 0.12^{bcA}	6.85 ± 0.13^{cA}	6.73 ± 0.07^{c}
Flavor	Control paneer	7.63 ± 0.05^{aA}	7.33 ± 0.12^{abA}	7.13 ± 0.13^{bA}	5.15 ± 0.13^{cA}	-
	Black pepper paneer	7.81 ± 0.12^{aA}	7.51 ± 0.13^{abA}	7.35 ± 0.15^{bcA}	7.01 ± 0.01^{cB}	5.28 ± 0.14^{d}
Overall acceptability	Control paneer	7.98 ± 0.10^{aA}	7.53 ± 0.05^{bA}	7.21 ± 0.10^{cA}	5.40 ± 0.13^{dA}	-
	Black pepper paneer	7.53 ± 0.07^{aB}	7.35 ± 0.13^{abA}	7.11 ± 0.12^{bcA}	6.98 ± 0.15^{cB}	5.31 ± 0.20^{d}

Note: Values with a different superscript (a, b) in a row or column (A, B between control and treated) are significantly different at $P<0.05$

Overall acceptability

Overall acceptability score of control and black pepper paneer during storage are given in Table-2 and 3, which showed that scores significantly decreased during storage ($p \leq 0.05$) at ambient and refrigeration temperature. Score of control and black pepper paneer decreased from 7.98 to 5.63 and from 7.53 to 5.71 respectively, in two days storage at ambient temperature (Table-2). While at refrigeration temperature, score of control in 12 days and black pepper paneer in 14 days storage decreased from 7.98 to 5.40 and from 7.53 to 5.31 respectively (Table-3). Table-2 showed that shelf life of control and black pepper paneer was only one day at ambient temperature. While shelf life of control and black pepper paneer were 8 and 12 days at refrigeration temperature (Table-3) respectively. Enhancement of shelf life of black pepper paneer may be due to low temperature, antimicrobial property of black pepper and synergistic effect of these factors. Kapoor (2014) [10] also reported that essential oil of black pepper enhanced the shelf life of orange juice.

Changes in microbial count of black pepper paneer during storage at 7±1°C

Control and black pepper paneer were analyzed for microbial counts viz. standard plate count (SPC) and yeast and mold count. The data obtained for changes in SPC and yeast and mold counts are presented in Fig.1 and Fig. 2.

Standard plate count (SPC)

It is clear from Fig.1 that SPC of control and black pepper paneer increased during the storage at refrigeration temperature. The count increased from 4.71 to 5.29 log_{10} cfu/g after 8 days in control paneer and from 4.63 to 5.42 log_{10} cfu/g after 12 days in black pepper paneer, was within the limit set by Bureau of Indian Standards for paneer. Control paneer on 12th day and treated paneer samples on 14th turned slimy and gave off flavor during storage at refrigeration temperature so the study was not carried out on that day. Kumar and Bector (1991) [11] reported an increase in SPC from 3.0×10^3 to 2.8×10^5 cfu/g on 4th day and 9.0×106 cfu/g on 7th day of control paneer during storage at 15 °C.

Yeast and mold count (YMC)

Fig. 2 shows that yeast and mold count increased sharply in case of control paneer, while in the black pepper paneer the count increased at a slower rate throughout the storage period. Count increased from 62 to 213 cfu/g after 8 days in control paneer and from 41 to 231 cfu/g after 12 days in black pepper paneer, which is within the limit of microbial count set by Bureau of Indian Standards for paneer. Kumar and Bector (1991) [11] reported that the yeast and mold count of control paneer increased from 10 per g to 50 per g after 4 days and 250 per g after 7 days of storage at 15 °C. Mishra *et al*. (2017) [16] also reported that SPC and yeast and mold count increased in paneer during storage at 7 °C

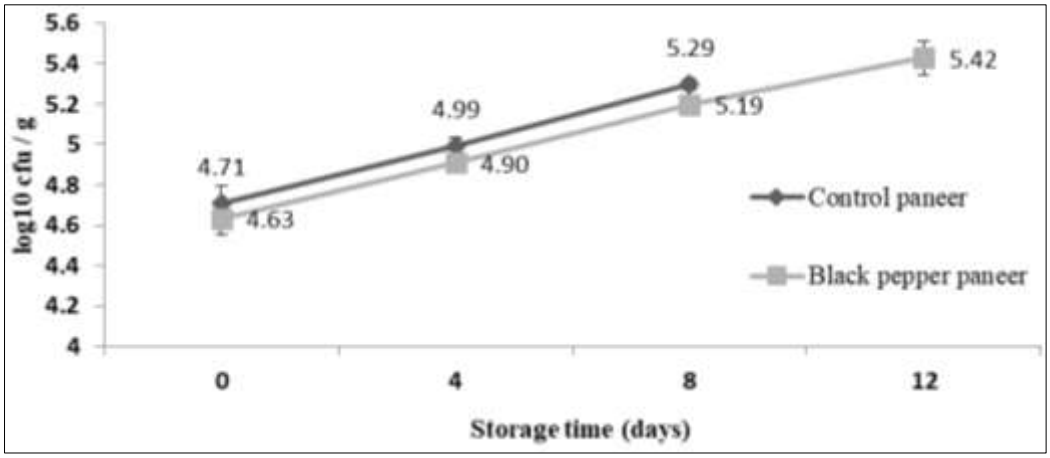

Fig 1: Changes in standard plate count (SPC) of black pepper paneer during at 7±1 °C

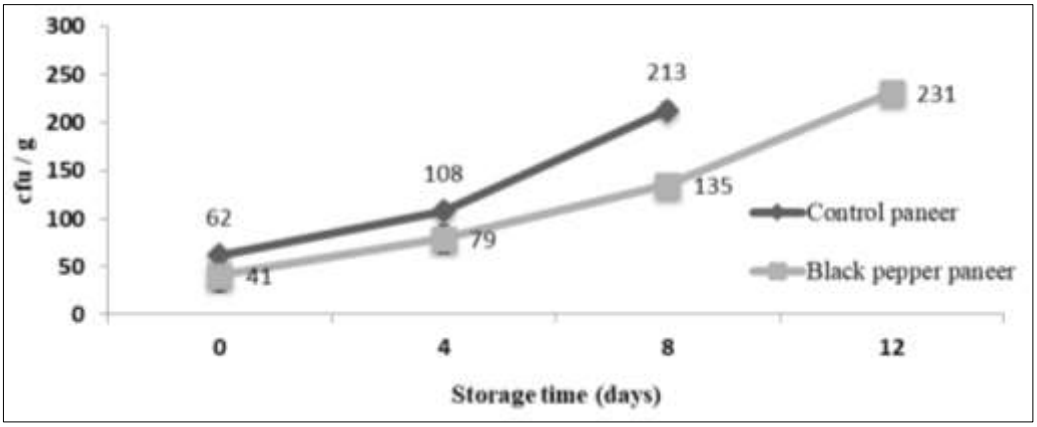

Fig 2: Changes in yeast and mold count of black pepper paneer during storage at 7±1 °C

Conclusion

Shelf life of treated sample was only one day at room temperature which is similar to control paneer. While at refrigeration temperature, shelf life of treated sample was 12 days and control was only 8 days. Thus black pepper extract did not enhance the shelf life of paneer at room temperature, while it slightly enhanced at refrigeration temperature in respect of control.

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