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Influence of microwave heating on microbiological quality of khoa

K. D. CHAVAN* AND M.B. KULKARNI
Department of Animal Science and Dairy Science, M.P.K.V. Rahuri, AHMEDNAGAR (M.S.) INDIA

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Influence of microwave heating with power levels (10 – 100%) and two timings (60 seconds and 80 seconds) on microbiological (SPC and YMC) quality of khoa during storage was studied. The treatments M_4T_1 M_6T_2 were found to be promising based on germicidal efficacy as well as the overall sensory quality of khoa samples. In case of treatments M_7T_2 onwards the multiplication rate of microorganism was quite negligible. It was further noticed the efficacy of killing the Yeasts and mould for the samples was more as compare to the killing other bacterial species. This may be evident from the data on the microbial counts for M_7T_2 in case of SPC and M_4T_2 in case of YMC.

Key words : Khoa, Microwave heating, Storage, SPC, YMC.

INTRODUCTION

Microwave heating refers to the use of electromagnetic waves of certain frequencies to generate heat in a material (Roussy and Pearce, 1995). Microwave energy has been gainfully utilized in the food industry for various applications including food preservation (George, 1997). Microwaveable convenience foods represent a rapidly growing segment of the food processing industry (Mathur and Sachdeva, 2000). Microwaves have been used to varying extent in a number of industrial food processing operations such as baking, blanching, cooking, dehydration, pasteurization, sterilization and tempering (Rosenberg and Bogi, 1987 a). Dairy industry applications of microwave processing include enhancement of pasteurization efficiency, thermizing milk prior to cheese manufacturing, inactivation of bacteriophase, in- package paneer making, clarification of butter into ghee, thermisation of yoghurt, cooking of cheese curd, plastisizing of provolone and mozzarella cheese and thawing of butter etc. (Mathur and Sachdeva, 2000). However, the application of microwave heating on bacteriological preservation of khoa has probably not been attempted. Hence this investigation is planned to utilize the microwave energy for enhancing the microbiological quality of dairy products like khoa.

MATERIALS AND METHODS

The present research work was carried out in the department of Animal Science & Dairy Science during the year 2003-2004, Post Graduate Institute, M.P.K.V. Rahuri, Dist. Ahmednagar (M.S.).

Preparation of khoa :
Khoa samples were prepared using the method of De and Ray (1952).

Application of microwave treatment :
Microwave heating power levels (domestic microwave oven) 100, 90, 80, 70, 60, 50, 40, 30, 20 and 10 per cent and heating time of 60 and 80 seconds were used for exposure for khoa samples.

Packaging of khoa :
The khoa samples, 200 g each were immediately filled into 250 g capacity sterile pp squat and packed with airtight lid.

The khoa samples so exposed were stored at room temperature (32 -37^0 C) throughout the experimental period.

Storage study :
The interval of analyzing samples for SPC and YMC were fixed on day 0, 3, 5, 7 and 10 or until the sample spoiled sensorily.

Microbiological quality :
The Standard plate count (SPC) and Yeast and mould count (YMC) of khoa samples were determined by following the method in IS: 1479 – Part III (1962).

The sensory attributes of khoa samples under different experimental treatments were subjected to using the method described in the IS: 6273, Part - I and II (1971) adopting 9 point Hedonic scale. A panel of 5 semi-trained judges was formulated for this purpose.

* Author for Correspondence

The experiment was laid out in Completely Randomized Design (CRD) with four replications. The data on microbial counts were transformed into square root values and used for calculation of S.E. and C.D.

Results and Discussion

Ten power levels viz., 10 to 100 as suggested by Medved (1986), in combination with two timings of exposure (60 and 80 sec.) were to be tested in the experimental trials, the number of khoa samples involved was 21 including a control. For convenience, at a time 3 power levels in combination with two timings of exposure along with control sample were tried in one set. Then at a time seven experimental samples were prepared and tested for microwave heating influence. The observations of these sets of experimental covering all the 21 samples were compiled and processed as a pooled analysis for the purpose of interpretation.

Standard plate count (SPC) :

The results (Table 1) revealed that the microwave heating was quite effective in killing the microorganisms. The initial SPC in the control sample, on day 0 (7.75×10^3 cfu/g) was reduced to zero in treatment sample M_5T_2. The differences due to treatments were significant ($P < 0.05$) for SPC during all the intervals of storage. The mean count for the samples under different treatments ranged from 0 to 7.75×10^3 and to 17.0×10^3 cfu/g on day 0 and 3 during storage. The corresponding counts for the days 5 and 7 varied from 0 to 50.25×10^3 and 73.5×10^3 cfu/g. While in the control sample (M_0T_0) the SPC increased almost ten times on day 7 of storage (from 7.75 to 73.50×10^3 cfu/g). The rate of multiplication of microorganisms under treatment M_5T_2 was reduced considerably. In case of the treatments M_7T_2 onwards the multiplication rate of the microorganisms was quite negligible. It was further noticed that as the power level of microwave heating was increased there was linear decline in the SPC on all the days of storage. Among the 21 treatments tried, the treatments M_4T_1 to M_6T_2 were found to be promising. In the treatments M_7T_2 onwards although the killing power of microwave heating was very high reducing the SPC to almost zero, the overall sensory quality was adversely affected making the product quite unsuitable for consumption (Table 3). Some of research workers also observed the reduction in SPC because of microwave heating in different food products (Fung and Cunningham, 1980; Schlegel, 1992; Heddleson and Doores, 1994; Sieber *et al.,* 1996).

Yeast and mould count (YMC) :

The data presented in Table 2 also revealed a similar pattern of reduction in the counts of yeast and mould in the khoa samples subjected to microwave heating. The differences due to the treatments were significant ($P < 0.05$) for YMC during all the intervals of storage. The mean count for the khoa samples under different treatments ranged from 0 to 8×10^2 to 18.75×10^3 cfu/g on day 0 and 3 during storage. The corresponding figures for days 5 and 7 varied from 0 to 50.5×10^3 and to 71.75×10^3 cfu/g. As noticed in case of SPC, in this case too, the treatments M_4T_1 to M_6T_2 were found promising based on germicidal property and the overall sensory quality of the product subjected to the microwave heating. It was further noticed that the efficacy of killing the yeast and mould for the samples was more as compare to the killing other bacterial species. This may be evident from the data on the microbial counts for M_7M_2 in case of SPC and M_4M_2 in YMC. From these treatments onwards both SPC and YMC become zero. This implies further that microwave heating was also more effective in killing surface microbes than inner core of the product. The data presented in Table 1 and 2 further point out that in some cases, the YMC was higher than that of the SPC. This might probably due to the favourable microenvironment (higher lactic acid and lower pH etc.) available for the yeasts and moulds that could have enhanced their multiplication and thereby the higher counts, while in case of the SPC due to the lag phase in their growth pattern their number might be reduced in subsequent stages of the storage (Yadav *et al.,* 1993).

Sensory quality :

The observations of the sensory evaluation of experimental khoa samples during the storage (Table 3) indicate that as the microwave heating power increased progressively the mean sensory scores for all parameters i.e. flavour, body and texture, colour and appearance and overall acceptability declined linearly on day 0 and also on the different days of storage upto 10^{th} day. In this case also the treatments M_4T_1 to M_6T_2 (Microwave heating power 40 per cent for 80 seconds to microwave power levels 60 per cent for 80 seconds) were found to be significantly different and better over the other treatments tried. It is quite interesting to see that the flavour of these samples were found to be improved as compared to the rest of other treatments on days 3, 5, 7 and 10 of storage. This might be attributed to the interaction of proteins and lipids as well as the proteins and carbohydrates because of the moderate heating temperature applied through the microwave.

Table 1 : Influence of microwave heating with different power levels and timings on SPC in khoa during storage

(Means of 4 trials)

Treatment	Storage period (days)			
	0 (x 10^3 cfu/g)	3 (x 10^3 cfu/g)	5 (x 10^3 cfu/g)	7 (x 10^3 cfu/g)
M_0T_0	7.75	17.0	50.25	73.50
	$(2.87)^{f}$	$(4.18)^{i}$	$(7.13)^{n}$	$(8.60)^{l}$
M_1T_1	6.50	16.25	42.5	73.0
	$(2.64)^{e}$	$(4.09)^{h}$	$(6.56)^{mn}$	$(8.57)^{k}$
M_1T_2	6.50	15.75	41.75	72.5
	$(2.64)^{e}$	$(4.03)^{h}$	$(6.50)^{l}$	$(8.54)^{k}$
M_2T_1	6.0	15.75	40.25	69.5
	$(2.55)^{d}$	$(4.03)^{h}$	$(6.38)^{kl}$	$(8.37)^{jk}$
M_2T_2	5.0	15.25	38.25	66.0
	$(2.34)^{d}$	$(3.97)^{gh}$	$(6.26)^{j}$	$(8.16)^{ij}$
M_3T_1	4.25	15.0	33.50	62.25
	$(2.17)^{cd}$	$(3.94)^{g}$	$(5.83)^{ij}$	$(7.92)^{I}$
M_3T_2	4.50	14.25	32.75	61.25
	$(2.24)^{cd}$	$(3.84)^{fg}$	$(5.77)^{h}$	$(7.86)^{hi}$
M_4T_1	3.75	9.5	17.0	26.25
	$(2.06)^{c}$	$(3.16)^{ef}$	$(4.18)^{gh}$	$(5.72)^{gh}$
M_4T_2	3.71	7.5	15.0	23.5
	$(2.05)^{c}$	$(2.83)^{de}$	$(3.93)^{fg}$	$(4.90)^{fg}$
M_5T_1	1.0	2.75	7.75	12.5
	$(1.18)^{b}$	$(1.79)^{d}$	$(2.88)^{ef}$	$(3.60)^{ef}$
M_5T_2	0.0	1.25	6.0	9.5
	$(0.71)^{a}$	$(1.31)^{cd}$	$(2.55)^{d}$	$(3.18)^{e}$
M_6T_1	0.0	0.75	1.5	5.0
	$(0.71)^{a}$	$(1.09)^{bc}$	$(1.4)^{cd}$	$(2.34)^{d}$
M_6T_2	0.0	0.25	1.25	5.0
	$(0.71)^{a}$	$(0.89)^{ab}$	$(1.31)^{bc}$	$(2.34)^{cd}$
M_7T_1	0.0	0.0	1.25	1.5
	$(0.71)^{a}$	$(0.71)^{a}$	$(1.31)^{bc}$	$(1.4)^{c}$
M_7T_2	0.0	0.0	0.5	1.0
	$(0.71)^{a}$	$(0.71)^{a}$	$(0.97)^{ab}$	$(1.22)^{b}$
M_8T_1	0.0	0.0	0.0	0.0
	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$
M_8T_2	0.0	0.0	0.0	0.0
	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$
M_9T_1	0.0	0.0	0.0	0.0
	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$
M_9T_2	0.0	0.0	0.0	0.0
	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$
$M_{10}T_1$	0.0	0.0	0.0	0.0
	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$
$M_{10}T_2$	0.0	0.0	0.0	0.0
	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$	$(0.71)^{a}$
S.E.±	0.075	0.062	0.072	0.083
C.D. at 5%	0.212	0.174	0.217	0.245

(Figures in parentheses indicate square root values)

Table 2 : Influence of microwave heating with different power levels and timings on YMC in khoa during storage
(Means of 4 trials)

Treatment	Storage period (days)			
	0 (x 10^2 cfu/g)	3 (x 10^3 cfu/g)	5 (x 10^3 cfu/g)	7 (x 10^3 cfu/g)
M_0T_0	8 (2.92)^{d}	18.75 (4.39)^{e}	50.5 (7.14)^{g}	71.75 (8.5)^{h}
M_1T_1	7.75 (2.88)^{d}	18.25 (4.33)^{e}	49.75 (7.09)^{g}	70.75 (8.44)^{h}
M_1T_2	7.25 (2.79)^{cd}	17.75 (4.27)^{e}	49.25 (7.05)^{fg}	70.25 (8.41)^{gh}
M_2T_1	6.5 (2.65)^{c}	17.75 (4.27)^{e}	48.25 (6.98)^{f}	66.5 (8.18)^{fg}
M_2T_2	6.25 (2.60)^{c}	17.50 (4.24)^{e}	47.25 (6.91)^{f}	62.5 (7.94)^{fg}
M_3T_1	5.5 (2.45)^{d}	16.25 (4.09)^{d}	31.0 (5.61)^{de}	60.25 (7.79^{df}
M_3T_2	5.5 (2.45)^{b}	14.25 (3.84)^{cd}	22.5 (4.80)^{cd}	35.5 (5.99)^{cd}
M_4T_1	0.6 (1.04)^{b}	1.0 (1.22)^{b}	1.3 (1.34)^{bc}	2.0 (1.58)^{bc}
M_4T_2	0 (0.71)^{a}	0.25 (0.87)^{b}	0.5 (0.96)^{ab}	0.8 (1.14)^{ab}
M_5T_1	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}
M_5T_2	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}
M_6T_1	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}
M_6T_2	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}
M_7T_1	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}
M_7T_2	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}
M_8T_1	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}
M_8T_2	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}	0 (0.71)^{a}
M_9T_1	0.0 (0.71)^{a}	0.0 (0.71)^{a}	0.0 (0.71)^{a}	0.0 (0.71)^{a}
M_9T_2	0.0 (0.71)^{a}	0.0 (0.71)^{a}	0.0 (0.71)^{a}	0.0 (0.71)^{a}
$M_{10}T_1$	0.0 (0.71)^{a}	0.0 (0.71)^{a}	0.0 (0.71)^{a}	0.0 (0.71)^{a}
$M_{10}T_2$	0.0 (0.71)^{a}	0.0 (0.71)^{a}	0.0 (0.71)^{a}	0.0 (0.71)^{a}
S.E.±	0.046	0.083	0.080	0.079
C.D. at 5%	0.129	0.243	0.228	0.234

(Figures in parentheses indicate square root values)

Table 3 : Influence of microwave heating on sensory quality of khoa during storage.

Treat.	Flavour					Body and texture					Colour and appearance					Overall acceptability			
Days	0	3	5	7	10	0	3	5	7	10	0	3	5	7	10	0	3	5	7
M_0T_0	8.7^{J}	7.3^{c}	4.50	4.00	3.20	8.70	7.60	7.20	5.30	5.30	8.60	8.00	6.70	5.30	4.20	8.60	7.70	6.10	4.80
M_1T_1	8.6^{IJ}	7.1^{a}	4.40	4.00	3.20	8.60	7.60	7.30	5.10	5.10	8.60	8.00	6.80	5.30	4.20	8.60	7.60	6.20	4.80
M_1T_2	8.6^{i}	7.1^{a}	4.40	4.00	3.20	8.60	7.40	7.20	5.10	4.90	8.60	8.00	6.80	5.20	4.30	8.60	7.50	6.20	4.80
M_2T_1	8.5^{h}	7.1^{a}	4.40	4.00	3.20	8.50	7.40	7.30	5.00	4.90	8.60	8.00	6.90	5.30	4.20	8.50	7.50	6.20	4.70
M_2T_2	8.6^{i}	7.1^{a}	4.50	4.00	3.20	8.50	7.30	7.20	5.00	4.90	8.50	8.00	6.80	5.30	4.00	8.50	7.50	6.20	4.80
M_3T_1	8.6^{i}	7.4^{c}	4.50	4.00	3.30	8.60	7.40	7.30	5.00	4.70	8.50	8.00	6.80	6.50	4.10	8.50	7.60	6.20	5.10
M_3T_2	8.6i	7.4^{c}	4.60	4.00	3.30	8.50	7.40	7.40	5.00	4.70	8.50	8.00	6.80	6.50	4.10	8.50	7.60	6.30	5.20
M_4T_1	8.6^{i}	7.9^{fg}	7.60	7.30	6.80	8.60	8.10	7.40	7.40	7.20	8.50	8.10	7.30	6.60	5.80	8.50	8.00	7.40	7.10
M_4T_2	8.5^{hi}	8.1^{g}	7.80	7.30	6.80	8.50	8.00	7.40	7.40	7.20	8.50	8.10	7.40	7.50	7.00	8.50	8.00	7.50	7.20
M_5T_1	8.5^{h}	8.3^{i}	7.90	7.40	7.40	8.50	8.10	7.90	7.50	7.20	8.50	8.00	7.70	7.60	7.20	8.50	8.10	7.80	7.50
M_5T_2	8.5^{h}	8.4^{j}	7.90	7.40	7.30	8.30	8.20	7.90	7.50	7.20	8.40	8.00	7.60	7.40	7.30	8.40	8.20	7.80	7.60
M_6T_1	8.4^{gh}	8.2^{h}	7.70	7.40	7.30	8.30	8.10	7.70	7.60	7.30	8.30	7.80	7.40	7.30	7.30	8.30	8.00	7.36	7.50
M_6T_2	8.4^{g}	8.2^{h}	7.60	7.20	7.20	8.20	7.30	7.20	7.20	6.80	8.20	7.80	7.30	7.20	6.90	8.30	7.80	7.30	7.30
M_7T_1	8.3^{fg}	7.8^{d}	7.50	7.10	6.80	8.00	6.90	7.00	7.00	6.50	8.30	6.80	6.70	6.30	6.10	8.20	7.10	7.10	6.80
M_7T_2	8.2^{ef}	7.8^{d}	7.00	7.00	6.70	7.80	6.90	6.60	6.40	6.20	7.90	6.70	6.70	6.30	6.00	8.00	7.10	6.80	6.60
M_8T_1	8.1^{de}	7.5^{c}	6.90	6.70	6.60	7.70	6.80	6.60	6.40	5.90	7.80	6.60	6.60	6.40	6.20	7.80	6.90	6.80	6.50
M_8T_2	8.0^{ed}	7.3^{c}	6.90	6.70	6.60	7.60	6.90	6.50	6.40	6.00	7.70	6.70	6.60	6.30	6.10	7.80	6.90	6.70	6.50
M_9T_1	8.0^{c}	7.2^{b}	7.60	6.60	6.40	7.00	6.90	6.50	6.40	5.90	7.60	6.60	6.50	6.20	5.90	7.50	6.90	6.60	6.40
M_9T_2	7.8^{bc}	7.2^{b}	6.90	6.50	6.40	6.90	6.50	6.40	6.20	6.00	7.20	6.60	6.50	6.10	0.90	7.30	6.70	6.60	6.20
$M_{10}T_1$	7.7^{ab}	7.0^{a}	6.80	6.50	6.40	6.80	6.50	6.00	5.70	5.50	7.00	6.50	6.50	6.20	6.00	7.30	6.70	6.40	6.10
$M_{10}T_2$	7.6^{a}	7.0^{a}	6.60	6.30	6.00	6.70	6.50	5.70	5.70	5.10	6.80	6.50	6.50	6.20	6.10	7.20	6.70	6.20	6.10
S.E±	0.051	0.046	0.069	0.037	0.039	3.27	0.039	0.039	0.053	0.037	0.049	0.044	0.042	0.031	0.040	3.078	0.026	0.025	0.028
C.D. at 5%	0.144	0.129	0.196	0.105	0.10	9.266	0.110	0.111	0.150	0.104	0.139	0.123	0.119	0.088	0.114	8.706	0.074	0.069	0.080

CONCLUSION

Thus the results clearly indicated that the khoa samples treated with 40 per cent microwave heating power for 80 seconds to 60 per cent microwave heating for 80 seconds was very effective in extending the shelf life and the product was acceptable upto 7 days on storage at room temperature (32 -37^0 C).

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