International Journal of Multidisciplinary Research and Development

IJMRD 2014; 1(5): 121-126
www.allsubjectjournal.com
Received: 26-09-2014
Accepted: 07-10-2014
e-ISSN: 2349-4182
p-ISSN: 2349-5979

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Different factors influencing to the water buffalo milk fermentation with sweet potato jam

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Abstract
The nutritive interest of water buffalo milk products is also higher than cows' because of the higher concentrations of protein, fat, lactose, minerals and vitamins in buffalo milk. We investigate different factors influencing to the water buffalo milk fermentation. Our results show that *Sacharomyces cerevisiae* supplementation 3%, fermentation temperature 30 ºC, sweet potato jam 20%, preservation temperature 15 ºC to get the best fermented milk.

Keywords: *water buffalo, sweet potato jam, sacharomyces cerevisiae, fermented milk.*

1. Introduction
World milk production has doubled in the last decade, with water buffalo milk production ranking second after bovine milk (Guo MR *et al.*, 1998). Water buffalo milk presents physicochemical features different from that of other ruminant species, such as a higher content of fatty acids and proteins. The physical and chemical parameters of swamp and river type water buffalo milk differs. Water buffalo milk contains higher levels of total solids, crude protein, fat, calcium, phosphorus and slightly higher content of lactose compared with those of cow milk (Walstra P *et al.*, 1999). In addition, buffalo milk and its derived products could be a good source of conjugated linoleic acid (CLA) for humans, like other food products from ruminants (Khanal *et al.*, 2004). CLA refers to a group of polyunsaturated fatty acids (PUFA) that exist as positional and stereoisomers of conjugated dienoeic acid (18:2). The predominant isomer in foods is the cis9, trans11-CLA also called rumenic acid (Kramer J *et al.*, 1998) and the trans10, cis12-CLA found primarily in foods containing beef or dairy products (Ma DWL *et al.*, 1999; Griinari JM *et al.*, 2000; Ritzenthaler KL *et al.*, 2001). Synthetic mixtures of CLA can also be readily purchased as nutritional supplements and are composed primarily of the cis9, trans11-CLA and trans 10, cis12-CLA isomers. Numerous potential physiological effects have been attributed to CLA including those related to its potential antiadipogenic, antidiabetogenic, anticarcinogenic, and antiatherosclerotic properties (Belury MA. 2002). Similar to the differences in cows' milk, changes in buffalo milk composition due to breed, geographical location, and feeding; and these variations would strongly affect the manufacturing conditions, sensory quality, and nutritional properties of yogurt products (Xue Han *et al.*, 2012).
The high level of total solids makes water buffalo milk ideal for processing into value added dairy products such as the fermented milk. Water buffalo milk is processed into a large variety of dairy products: cream churns; butter; ghee; paneer, khoa, rabri, kheer and basundi; fermented milk; whey; soft cheeses; the semi-hard cheese; hard cheeses; watered-down buffalo milk (*VS Jayamanne, U Samarajeewa*, 2010; Faten Lotfi Seleet *et al.* 2011).
Purpose of our research is to investigate different factors influencing to the water buffalo milk fermentation such as *Sacharomyces cerevisiae* supplementation, fermentation temperature, sweet potato jam, chilling preservation temperature to get the best fermented milk.

2. Material & Method
2.1 Material
Water buffalo milk is collected in Mekong river delta, Vietnam. Raw buffalo milk is stored in big steel containers before being transported to laboratory.

Fig1: Water buffalo and its milk

Fig 2: Sweet potato jam.

2.2 Research method

2.2.1 Chemical composition analysis in raw material

Protein: by Kjeldahl method
Lipid: by Gerber method
Dry matter: by drying to basic weight
pH: by pH meter
Coliform: by colony counting
Acidity: by titration

2.2.2 Experiment #1: Effect of yeast ratio and fermentation temperature to the fermented milk quality

Table 1. Experimental arrangement #1

Temperature (°C)	Sacharomyces cerevisiae (%)		
	1 (A1)	**3 (A2)**	**5 (A3)**
30 (B1)	A1B1	A2B1	A3B1
37 (B2)	A1B2	A2B2	A3B2
42 (B3)	A1B3	A3B3	A3B3

Mixture of buffalo milk and sugar has the soluble dry matter 18%. It's heated to 65-70 ^{0}C with pressure 250 kg/cm2 in 4 minutes. The fermentation is performed as in table 1 above. During this process, we monitor lactic acid formation until its value 0.70-0.75%, then we mix with it with sweet potato jam 10%, continue the fermentation until lactic acid value 0.9-1.0%. The fermented milk is preserved at 4 ^{0}C. Experiment is randomly designed with triplication. Testing parameters include structure, appearance and flavour of product as well as the fermentation time.

2.2.3 Experiment #2: Effect of sweet potato jam ratio to the fermented milk quality

We perform the experiment #2 with the optimal parameter as in experiment #1, but change the sweet potao jam ratio (10, 15, 20%). Fermentation ceases when lactic acid reachs 0.9-1.0%. The fermented milk is preserved at 4 ^{0}C. Experiment is randomly designed with triplication. Testing parameters include structure, appearance and flavour of product.

2.2.4 Experiment #3: Effect of final fermentation temperature to the fermented milk quality

We perform the experiment #2 with the optimal parameter as in experiment #1 & 2, but change the final fermentation temperature 15 °C and 28-30 ^{0}C. Fermentation ceases when lactic acid reachs 0.9-1.0%. The fermented milk is preserved at 4 ^{0}C.

Experiment is randomly designed with triplication. Testing parameters include structure, appearance and flavour of product.

2.3 Statistical analysis

All data are processeed by ANOVA using Statgraphics 6.0.

3. Result & Discussion

3.1 Chemical composition analysis in raw material

Table 2: Chemical composition in raw buffalo milk

Composition	Percentage
Protein	4.20%
Lipid	3.28%
Lactose	3.64%
Dry matter	11.56%
Coliform	180 (CFU/ml)
pH	6.60

3.2 Effect of yeast ratio and fermentation temperature to the fermented milk quality
3.2.1 Effect of yeast ratio to lactic acid formation and fermentation temperature to the fermented milk quality

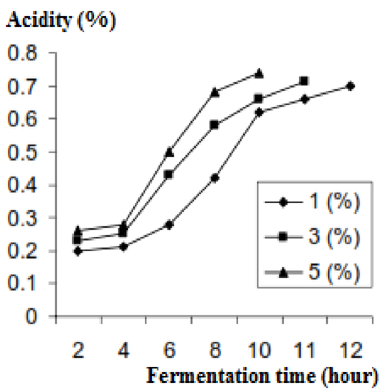

Fig 3: Lactic acid formation by fermentation time at 30 ^{0}C

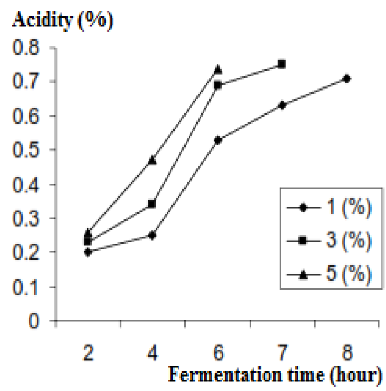

Fig 4: Lactic acid formation by fermentation time at 37 ^{0}C

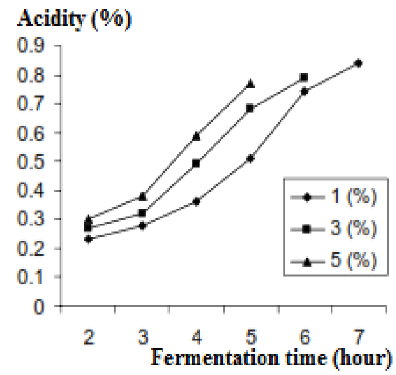

Fig 5: Lactic acid formation by fermentation time at 42 ^{0}C

Table 3. Effect of yeast ratio and fermentation temperature to the fermentation time and lactic acid formation

Temperature (^{0}C)	Yeast ratio (%)	Fermentation time (hour)	Acidity increasement (%)
30	1	16	0.05
30	3	15	0.06
30	5	14	0.07
37	1	12	0.065
37	3	11	0.075
37	5	10	0.080
42	1	9	0.070
42	3	8.5	0.080
42	5	8	0.090

At high fermentation temperature (37-42 ^{0}C), lactic bacteria can grow better than low fermentation temperature (30 ^{0}C).

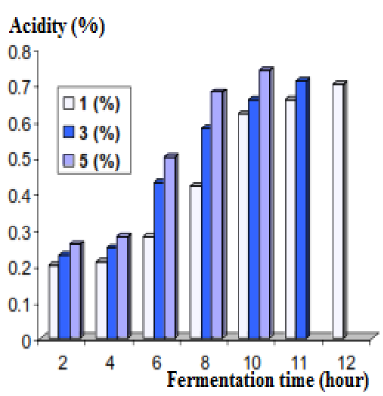

Fig 6: Fermentation time by yeast ratio at 30 ^{0}C

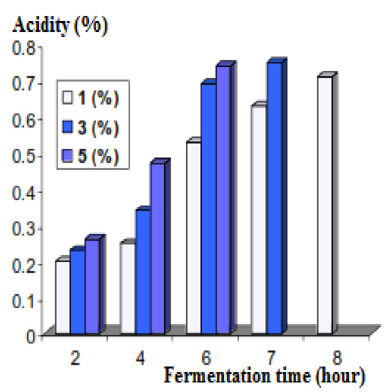

Fig 7: Fermentation time by yeast ratio at 37 ^{0}C

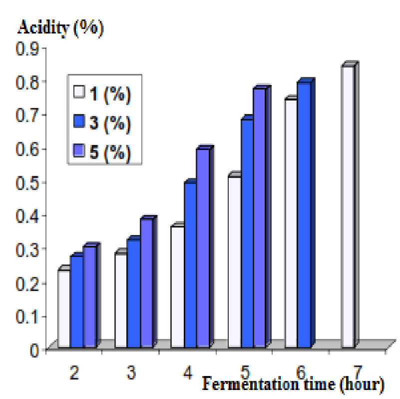

Fig 8: Fermentation time by yeast ratio at 42 ^{0}C

From figure 6, 7 & 8 the lactic acid formation is optimal when being fermented at 5% yeast ratio.

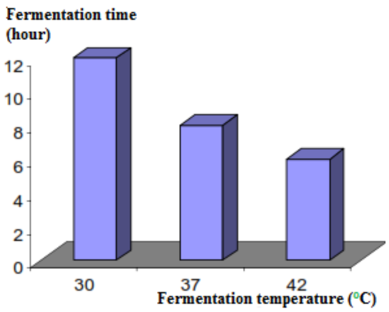

Fig 9: Fermentation time by fermentation temperature at yeast ratio 1%

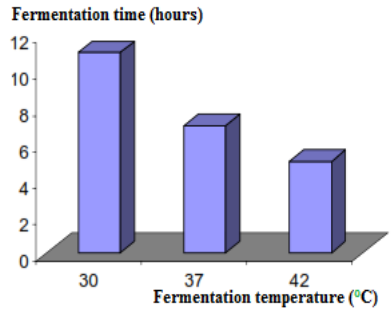

Fig 10: Fermentation time by fermentation temperature at yeast ratio 3%

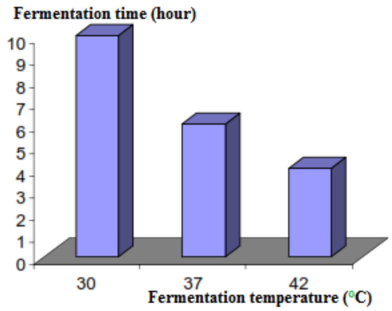

Fig 11: Fermentation time by fermentation temperature at yeast ratio 5%

From figure 9, 10, 11 we can see that with the same yeast ratio, fermentation at high temperature (42 ^{0}C) will produce more lactic acid. With above data, the fermentation at 42 ^{0}C and yeast ratio 5% we will get the best lactic acid formation as well as the calcium-caseinate-phosphate coagulation.

3.2.2 Effect of yeast ratio and fermentation temperature to the fermentation time and lactic acid formation during chilling preservation

Chilling preservation plays role to create special flavour and structure for product.

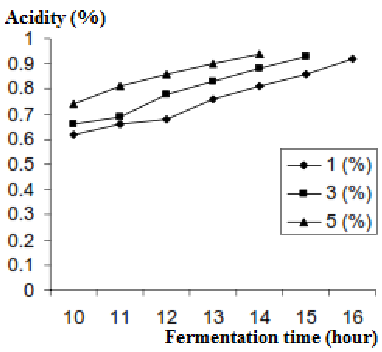

Fig 12: Lactic acid formation during the chilling preservation by different yeast ratios at temperature 30 ^{0}C

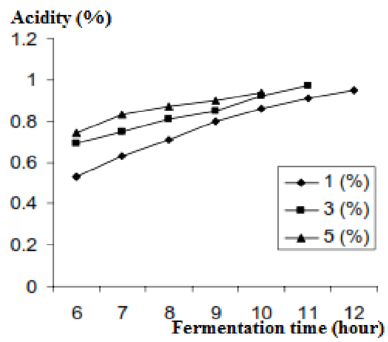

Fig 13: Lactic acid formation during the chilling preservation by different yeast ratios at temperature 37 ^{0}C

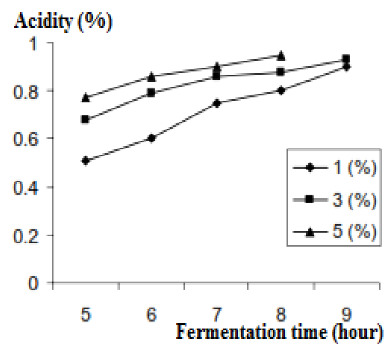

Fig 14: Lactic acid formation during the chilling preservation by different yeast ratios at temperature 42 ^{0}C

While fermentation at 42°C and yeast ratio 5%, the chilling preservation is quickly established.

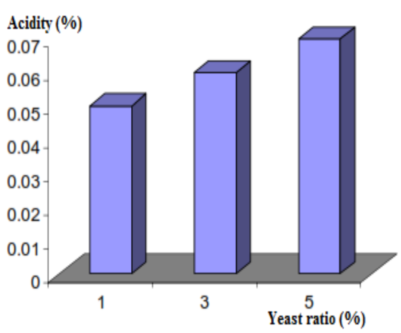

Fig 15: Lactic acid increasement during the chilling preservation by different yeast ratios at fermentation temperature 30 ^{0}C

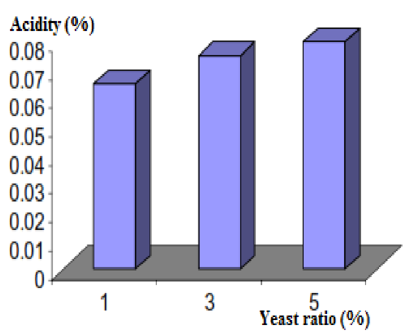

Fig 16: Lactic acid increasement during the chilling preservation by different yeast ratios at fermentation temperature 37 ^{0}C

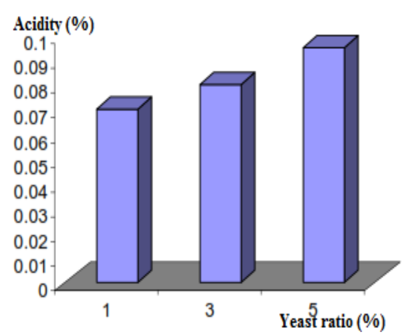

Fig 17: Lactic acid increasement during the chilling preservation by different yeast ratios at fermentation temperature 42 ^{0}C

With yeast ratio 5%, the lactic acid increasement is strongly established.

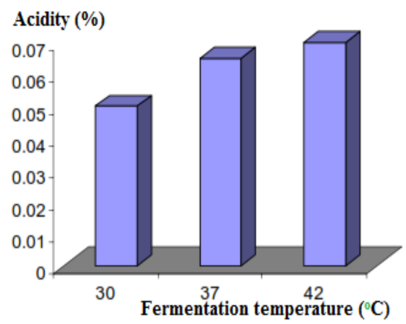

Fig 18: Lactic acid increasement during the chilling preservation by different fermentation temperatures at 1% yeast ratio

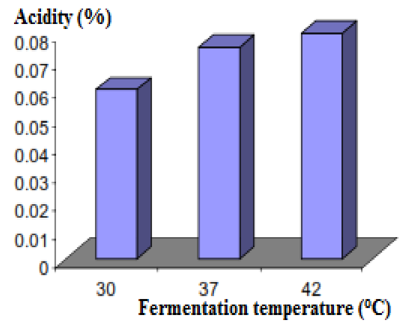

Fig 19: Lactic acid increasement during the chilling preservation by different fermentation temperatures at 3% yeast ratio

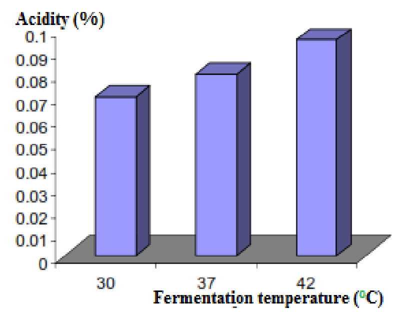

Fig 20: Lactic acid increasement during the chilling preservation by different fermentation temperatures at 1% yeast ratio

With fermentation temperature 42 ^{0}C and yeast ratio 5%, we get the most lactic acid in the shortest fermentation time.

3.2.3 Effect of fermentation temperature and yeast ratio to lactic bacteria growth during fermentation

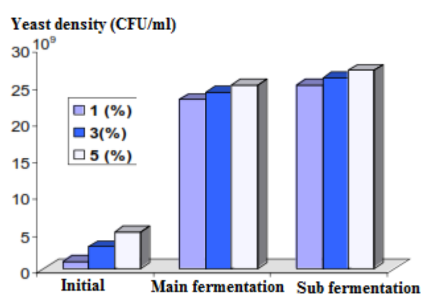

Fig 21: Yeast density in different stages (30 ^{0}C)

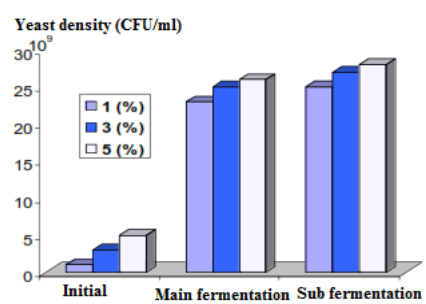

Fig 22: Yeast density in different stages (37 ^{0}C)

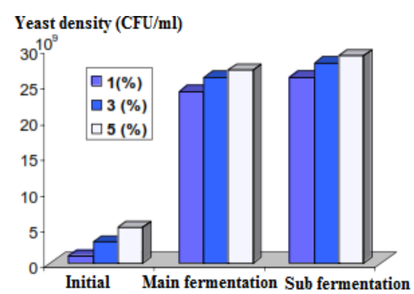

Fig 23: Yeast density in different stages (42 ^{0}C)

3.2.4 Effect of yeast ratio and fermentation temperature to the sensory characteristics of fermented milk

Table 4: Sensory sensory characteristics of fermented milk by the yeast ratio at different fermentation temperatures

Temperature (°C)	Yeast ratio (%)	Appearance	Flavor
30	1	3.44^c	3.19^c
37	1	3.25^d	3.25^c
42	1	3.06^e	3.25^c
30	3	4.56^a	3.63^a
37	3	4.31^b	3.50^b
42	3	3.00^c	3.34^c
30	5	4.25^b	3.31^c
37	5	2.88^f	3.44^{abc}
42	5	3.31^d	3.31^c
		F= 20.2	F= 1.36
		P= 0.000	P= 0.221

Fermentation 30 ^{0}C with 3% yeast ratio we get the best fermented milk sensory characteristics such as appearance, structure and flavour.

3.3 Effect of the sweet potato jam supplementation to sensory characteristics of the water buffalo fermented milk

Table 5: Average sensory score of the fermented milk by different ratios of the sweet potato jam

Sweet potato jam ratio (%)	Appearance	Flavor
10	4.69^a	3.13^b
15	4.50^a	3.31^b
20	4.56^a	4.13^a
	F= 0.58	F= 29.32
	P= 0.566	P= 0.000

From table 5, we don't see the statistically significant difference about structure, appearance, flavour. All the fermented milk has fine structure and uniform. However, we can notice the difference about flavour. At 20% sweet potato jam, the buffalo fermented milk has the best sensory characteristics.

3.4 Effect of the final fermentation temperature to the fermentation time and product quality

Table 6: Average score of sensory characteristics at different fermentation temperatures

Fermentation temperature (^{0}C)	Fermentation time (hour)	Appearance	Flavor
28-30	13	3.625^b	4.125^b
15	16	4.313^a	4.250^a
		F= 12.35	F= 0.20
		P= 0.001	P= 0.658

From table 6, we see the statistically significant difference about structure but not flavour. When supplementing with sweet potato jam, we notice the special flavour. At 15ºC, product has fine structure.

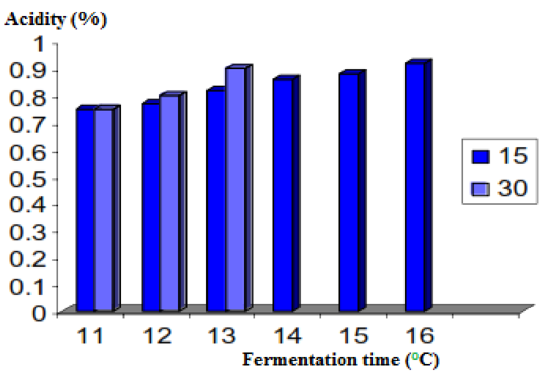

Fig 24: Fermentation time by fermentation temperature during the chilling preservation

4. Conclusion

Buffalo's milks are used for the manufacture of yogurt. Buffalo milk contains about twice as much butterfat as cow milk and higher amounts of total solids and casein, making it highly suitable for processing various types of yogurt and resulting in creamy textures and rich flavor profiles. We have successfully investigated different factors influencing to the water buffalo milk fermentation.

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