INT. J. BIOL. BIOTECH., 13 (1): 7-11, 2016.

EFFECT OF MALTODEXTRIN AND WHEAT FIBER ON VIABILITY OF *LACTOBACILLUS PARACASEI* SUBSP. *PARACASEI* AND PHYSICOCHEMICAL PROPERTIES OF PROBIOTIC FREE-FAT STIRRED-TYPE YOGHURT

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ABSTRACT

Yoghurt is one of the most popular fermented dairy products in the world. The aim of this study was to evaluate the effect of maltodextrin and wheat fiber on viability of probiotics and physicochemical properties of probiotic free-fat stirred yoghurt. Prebiotics including maltodextrin and wheat fiber (solely or in combination together) and *Lactobacillus paracasei* subsp. *paracasei* were used to produce yoghurt. pH, acidity, syneresis, viscosity and probiotic cell count of yoghurt samples were determined on 1^{st}, 7^{th}, 14^{th} and 21^{st} day of cold storage. Yoghurt sample containing maltodextrin and wheat fiber in combination together had the highest probiotic cell count, the least syneresis and the highest viscosity on 21^{st} day of storage. In all samples, pH and probiotic cell count decreased significantly ($p<0.05$) during the storage while acidity, viscosity and syneresis increased significantly ($p<0.05$). It can be concluded that maltodextrin and wheat fiber can reduce syneresis and pH, and increase probiotic cell count and acidity of yoghurt samples compared with control sample. In all samples (excluding control), the probiotic cell count was more than 10^6cfu/mL until the end of 21^{st} day which shows the efficiency of using maltodextrin and wheat fiber in formulation of the probiotic yoghurt.

Key- words: *Lactobacillus paracasei* subsp. *paracasei,* Maltodextrin, Probiotic yoghurt, Wheat fiber

INTRODUCTION

Nowadays, probiotic products are one of the most important functional foods. The definition of probiotics has been wide range at the recent century and it defined as live microorganisms which improve the natural micro flora of host and has useful effects on consumer health ((Klaenhammer and Kullen, 1999)). *Lactobacillus paracasei* subsp. *paracasei* is a probiotic strain belongs to lactic acid bacteria group, investigation shows the less use of this strain in probiotic products. Although there is no public agreement on the minimum number of alive probiotic bacteria, but generally $>10^6$cfu/ml probiotic bacteria is necessary to outbreak the healthful effects (Moller and Vrese, 2004). So consuming 100 g of probiotic product contains mentioned number of active bacteria per each gram of product can cover this optimum range (Aghajani *et al*., 2012). Among the fermented milk products, yoghurt is very important. Yoghurt obtained from fermentation of milk by *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* and it is known as set and stirred types. In recent years, a product called probiotic yoghurt, has been produced by use of probiotic bacteria, which is known as a healthful and functional food. This product is the best well-known carrier of probiotic bacteria transferring them to the cosumers (Mohebbi and Ghoddusi, 2008). Prebiotics are indigestible nutritive materials that are causing growth and activity of one or more useful probiotic bacteria in garrulous (Aghajani *et al*., 2012). Maltodextrin is a combination of nutritive and unsweetened saccharide polymers that is obtained from short hydrolysis of food grade starch then its purification and concentration (Marlett *et al.,* 2002). Splicer or Cohesion, absorbent, jel making, plasticizer, sweetener and desirable solubility are the most important properties of maltodextrin (Sadeghi *et al.,* 2008). Wheat fiber is a nutritive product and has lower energy level compare to processed products. It can absorb water 3-5 times more than its weight and improve the texture and stability of the products. Synbiotic products (combination of probiotics and prebiotics) have healthful benefits for the host (James and Anderson, 2001).

Recently production and consuming of full fat stirred yoghurt is increasing that is harmful for the consumer. So a supplement product is needful which is according to consumer’s taste. Also fat content reduction in this product leads to more profitability and persuasion of producers to produce it. The aim of this study was to evaluate the effect of adding maltodextrin and wheat fiber on viability of *Lactobacillus paracasei* subsp. *paracasei* and physicochemical properties of free-fat stirred probiotic yoghurt.

MATERIALS AND METHODS

Ingredients

Ingredients included skim milk from Tehran milk industry Co. (Pegah); Maltodextrin from Pars Esta Co., Iran; Wheat fiber from JRS Co., Germany; yoghurt starter culture (YF L-903) and *Lactobacillus paracasei* subsp. *paracasei* (*L.casei*-431) from CHR HANSEN Co., Denmark. The starters were freeze-dried and DVS.

Producing Probiotic Free-fat Stirred Yoghurt

Prebiotic compounds including maltodextrin and wheat fiber were added to skim milk (solely or in combination together) and mixed completely at 50-55˚C. Milk was heated at 80-85˚C for 15 minutes, then cooled up to 40 ˚C and after that yoghurt starter (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus)* and *Lactobacillus paracasei* subsp. *paracasei* were inoculated to milk simultaneously. The count of probiotic bacteria was 10^8cfu/mL. The ratio of probiotic bacteria to yogurt starter was 2:1. The next step was incubating at 40˚C until pH 4.7, then stirring the yoghurt flocculation at 30˚C and transferring it to the refrigerator (4˚C). The probiotic yoghurt samples were stored for three weeks at 4˚C.
The samples of this study are shown in Table 1.

Table1. The samples of this study

Sample	Ingredients	Concentration (w/w %)
M	Maltodextrin	2
W	Wheat fiber	1
MW	Maltodextrin and wheat fiber in combination together	2 and 1, respectively
C	Control (without any additives)	-

Physicochemical analysis

Acidity was measured according to AOAC method (AOAC, 2002).

Syneresis was measured by centrifuge. In order to measure syneresis, yoghurt samples were stirred and filled to the special 25ml test tubes, then they were put in the centrifuge machine and centrifuge them at 4˚C with spin 350×g for 30 minutes. After centrifuging, the separated serum volume, at the top of test tube, was measured and the division outcome of separated serum volume to the primary yoghurt volume is equal to syneresis percentage (Gonzalez – Martinez *et al.*, 2002).

Viscosity was measured by means of Brookfield viscometer (model RV-DVII). In order to measure viscosity, the appropriate spindle is spindle No 6 in spin 100 rpm (with respect to machinery instruction, the appropriate spindle for viscosity measurement, is the spindle has more than 10% torque in desired spin). All tests were done at 5 ˚C and 15 seconds spindle rotation (Akin *et al.,* 2007).

Enumeration of Lactobacillus paracasei subsp. paracasei

Enumeration of probiotic bacteria was done based on pure plate method by use of MRS bile agar. Incubation was conducted under anaerobic condition at 37 ˚C for 48 hours (Hekmat and Reid, 2006).

Statistical analysis

This study was conducted as factorial and in a quite random format. One way Analysis of Variance (ANOVA) was used for statistical analysis of physicochemical and microbial properties of probiotic yoghurt samples after fermentation, and the mean of treatments was compared by Duncan test. For each trial, general liner model (GLM) with repetitive extents during the time was used and the mean of treatments was compared by Duncan test. All experiments were performed in triplicate. Statistical analysis was done by SPSS (Version 18) Software.

RESULTS

Physicochemical properties

The amounts of acidity of the samples are shown in Table 2. Acidity of the samples increased significantly ($P<0.05$) during the storage time. There was no significant difference ($p>0.05$) between samples in terms of acidity.

The amounts of syneresis of the samples are shown in Table 3. Syneresis increased significantly ($p<0.05$) during cold storage. The lowest amount of syneresis was belonged to sample M and Sample MW. The control sample had the most amount of syneresis at the end of storage time.

The amounts of viscosity of the samples are shown in Table 4. According to the results, viscosity increased significantly ($p<0.05$) during the storage, but its intensity decreased during 14th and 21st days of storage. Sample MW had the most amount of viscosity during 21 days of storage. The lowest amount of viscosity was related to control sample.

Probiotic bacterial count

Probiotic bacterial count of the samples is shown in Table 5. According to the results, samples containing maltodextrin and wheat fiber (solely or in combination together) had the highest count of probiotic bacteria after 21 days of storage. The lowest count of probiotic bacteria was related to control sample. The viability of probiotic bacteria reduced significantly ($p<0.05$) by increasing the storage time.

Table 2. Acidity amounts of probiotic free-fat stirred yoghurt samples during cold storage.

Yoghurt sample	1st Day	7th Day	14th Day	21st Day
M	63.83±0.334 ^{a}	76.00±0.015 ^{a}	82.00±0.029 ^{b}	94.33±0.111 ^{a}
W	65.33±0.381 ^{a}	76.16±0.019 ^{a}	85.50±0.014^{ab}	91.33±0.101 ^{b}
MW	64.66±0.342 ^{a}	78.50±0.024 ^{a}	89.33±0.031^{ab}	94.16±0.106^{ab}
C	66.50±0.238 ^{a}	76.00±0.031 ^{a}	88.00±0.052^{ab}	94.66±0.122^{ab}

Similar letters indicate non-significant difference at $p>0.05$.

Table 3. Syneresis amounts of probiotic free-fat stirred yoghurt samples during cold storage.

Yoghurt sample	1st Day	7th Day	14th Day	21st Day
M	25.20±0.089^{ef}	26.48±0.082 ^{f}	34.45±0.078^{d}	45.26±0.204^{cd}
W	28.88±0.073^{bc}	30.27±0.066 ^{c}	35.73±0.072^{c}	46.45±0.251^{b}
MW	26.44±0.034 ^{de}	28.04±0.072 ^{e}	33.17±0.001^{e}	45.10±0.094^{cd}
C	32.66±0.091 ^{a}	38.39±0.084 ^{a}	42.19±0.069^{a}	47.21±0.144^{a}

Similar letters indicate non-significant difference at $p< 0.05$.

Table 4. Viscosity amounts of probiotic free-fat stirred yoghurt samples during cold storage.

Yoghurt sample	1st Day	7th Day	14th Day	21st Day
M	1413.33±0.249^{ab}	1432.33±0.121^{ab}	1442.66±0.093 ^{a}	1445.33±0.031 ^{a}
W	1411.33±0.244^{ab}	1430.66±0.114 ^{b}	1440.66±0.014 ^{a}	1443.00±0.009 ^{a}
MW	1414.66±0.171 ^{a}	1433.33±0.103^{ab}	1444.00±0.092 ^{a}	1447.00±0.052 ^{a}
C	1407.00±0.214 ^{b}	1416.00±0.247 ^{c}	1426.00±0.183 ^{b}	1418.00±0.015 ^{a}

Similar letters indicate non-significant difference at $p < 0.05$.

Table 5. Probiotic bacterial count of probiotic free-fat stirred yoghurt samples during cold storage.

Yoghurt sample	1st Day	7th Day	14th Day	21st Day
M	8.53±0.128 ^{a}	8.38±0.002^{a}	7.31±0.024^{a}	7.23±0.012 ^{a}
W	8.51±0.114^{a}	8.35±0.051 ^{a}	7.46±0.018^{a}	7.20±0.119 ^{a}
MW	8.49±0.128^{a}	8.39±0.029 ^{a}	7.47±0.032^{a}	7.32±0.051 ^{a}
C	7.49±0.097^{b}	7.67±0.017^{b}	7.37±0.004^{a}	7.07±0.009 ^{b}

Similar letters indicate non-significant difference $p< 0.05$.

DISCUSSION

Physicochemical properties

Acidity of the samples increased significantly (P<0.05) during the storage time. In a similar study, use of fibers especially in combination with similar compounds caused to increase the acidity during the storage time (Vahcic and Hruskar, 2002). In case of using prebiotics, despite protective effect of these compounds on probiotics, stimulation of mentioned bacteria would increase their growth and activity; subsequently the acidity would increase during the storage time (Tabatabaie and Mortazavi, 2008)

By the passing of time, syneresis of yoghurt samples increased significantly (P<0.05). pH reduction at the end of storage time, caused to deformation of protein and also the bound water has been released due to the denaturation of protein (Sahana *et al*., 2008).

Viscosity of the samples increased significantly (P<0.05) during the storage time. The sample containing maltodextrin and wheat fiber (in combination together) had the highest amount of viscosity. Some researchers have evaluated the effects of different dietary fiber types on the rheological properties of yoghurt. They have reported fiber type used in yoghurt production has a significant effect on rheological properties of yoghurt. Also they showed that storage time is effective. Use of fiber in yoghurt lead to change its structure, if fiber added well enough; it can improve texture and viscosity by means of water absorption and holding (Staffolo *et al.*, 2004).

Probiotic bacterial count

Adding maltodextrin and wheat fiber caused to improving growth and activity of probiotic bacteria and more viability in compare to control yoghurt sample which lacked this compounds. In all samples, the trend of the number of live bacteria during cold storage was descending. Other researchers have approved these results, that adding prebiotics lead to increase the viability of probiotics in a defined time. The viability of probiotic bacterias in probiotic yoghurt is related to some factors such as the used species, interaction between species in culture media condition, chemical composition of fermented culture media, final acidity, milk solids, temperature and inoculation level (Hekmat and Reid, 2006). Reports indicate that the number of live probiotic bacteria in probiotic products consumption must be at least 10^6 CFU/mL (Sharp *et al*., 2008). The Production of large amounts of acid by yoghurt starter bacteria, and the lack of growth promoting compounds such as prebiotic on the other hand, causes a significant reduction in the number of probiotic bacteria in the control sample.

CONCLUSION

It can be concluded that using wheat fiber and maltodextrin in combination together had more favorable results than the use of these compounds individually. The main reason for this result can be synergistic behavior of these compounds in the formulation of probiotic yoghurt, as well as stimulate growth of probiotics and improve rheological properties of fermented products during the storage time. According to the results of this study, the yoghurt contains combination of wheat fiber and maltodextrin had the most alive probiotic cell count, the least syneresis and the most viscosity at the end of 21 days of storage.

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(*Accepted for publication December 2015*)