© 2015 IJSRST | Volume 1 | Issue 5 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Development of Guava Probiotic Dairy Beverages : Application of Mathematical Modelling between Consumer Acceptance Degree and Whey Ratio

Hamad, M. N. F.*[1], M. K. El-Nemr[2]
*[1]Dairy Department, Damietta University/Faculty of Agriculture, Damietta, Egypt
[2]Agricultural Engineering Department, Damietta University/Faculty of Agriculture, Damietta, Egypt

ABSTRACT

Twenty One guava probiotic dairy beverages (*Lactobacillus aciophilus* LA-5 "2% vol/vol" "T_1", *Bifidobacterium bavidium* "2% vol/vol" "T_2" and *Lactobacillus aciophilus* LA-5 "1% vol/vol" and this ratio in *Bifidobacterium bavidium* "T_3") were produced using 0, 20, 35, 50, 65, 80 and 100% (vol/vol) (unsalted whey) which is a product of Ras cheese manufacturing in their formulations and the same percentage interchangeably with cow's milk. The adding of whey had effected on pH values in T_1 treatments. The highest pH values (5.039 to 5.173) recorded in the T_2 treatments, while less values (4.083 to 4.246) recorded in T_1 treatments, but in "T_3 treatments" were a medium values (4.313-4.627±0.012). The effect of adding whey on counts of *B. bavidium* in "T_2" treatments and *L. aciophilus* in "T_2 and "T_3" treatments were highly significant ($p \leq 0.001$), while, non-significant effect ($p=0.609$) of adding whey was showed on *B. bavidium* ("T_3" treatments). In T_1, T_2 and T_3 treatments, the higher values of consumer acceptance degree were 7.267, 7.567 and 7.767 out (9), respectively at 35% whey, while lower values 5 was showed at 0% and 80% whey in T_1 treatments, and (3.233 and 3.867) at 100% whey in T_2 treatments" and T_3 treatments. Mathematical Modelling was created to describe the relationship between consumer acceptance degree (C) and the whey ratio (W) at each type of the previously mentioned starters. Sinusoidal modelling was resulted with a standard error ranging between (0.38 or 0.40). This study is utilized to improve the product, the production of quality products, different consumer degrees and use of dairy wastes "whey", giving an economic value.
Keywords : Guava, mathematical modelling, probiotic, consumer acceptance degree

I. INTRODUCTION

Guava (Psidium gujava L.) is widely distributed throughout Egypt. Damietta governorate is considered one of the main districts of guava production in Egypt. The Guava is a soft thin-skinned fruit, sweet in taste and white flesh and many seeds within. It is very susceptible to physical damage. Also, it is highly perishable of ten with potential shelf life of only 2-3 days. Most guava yield are marketed by street vendors. Three days later, the remained fruits have sever decay disorders and become useless. Guava fruit were contains 80% moisture, 20% dry matter, 1% ash, 0.7% fat and 1.5% protein. It is a rich source of Vitamin C and contains other nutraceutical components such as vitamin A, vitamin B_1, B_2, niacin and pantothenic acid. In addition, it also contains a fair amount of phosphorous, calcium, iron, potassium and sodium [1], broad spectrum of phytochemicals including polysaccharides, essential oils [2 and 3], alkaloids, glycosides, steroids [4], tannins, triterpenes, lectins, fatty acids, dietary fiber, manganese, oxalic and malic acids [5], phenolic compounds [6]. It's contain both major classes of antioxidant pigments such as carotenoids and polyphenols [7].

Its combination with probiotic fermented dairy food like yoghurt, curd and shrikhand will develop high value commodities to increase application of guava in the area of functional foods [8]. Conversion of whey into soft beverages is one of the most attractive avenues for utilization of whey for dairy industry. [9] developed beverage from paneer whey and guava. Here product diversification using whey as a partial replacement of water without much change in quality is quite [10]. Such beverages may be beneficial for the people suffering from gastro-intestinal tract disorders and can be used as

therapeutic soft drinks. The popularity of yogurt products continues to grow; manufacturers are continuously investigating value-added ingredients such as prebiotics and probiotics to entice health-conscious consumers. Probiotics are referred to as "live microorganisms, which when administered in adequate amounts confer a health benefit on the host" [11]. Lactobacillus and Bifidobacteria species are the most common types of probiotics. Prebiotics are classified as "non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improve host health" [12]. Currently, the most widely accepted prebiotics include fructooligosaccharides and galactooligosaccharides [13]. When prebiotics are combined with probiotics, their relationship is classified as synbiotic. This combination can improve the survival rate of the probiotics and provide additional health benefits to the host [14]. Whey contains more than half the solids present in the original whole milk including 20% of the proteins and most of the lactose, minerals and water soluble vitamins. There has been increased recognition that the proteins and lactose in whey are voluble nutrients which should not be wasted [15]. In Egypt, most of the whey produced is from Domiati cheese processing (salted whey) little amounts are produced from Ras cheese processing (unsalted whey).

The main objectives of this study were (1) to produce an guava probiotic dairy beverages similar to commercial products that will serve as a basis of comparison for fermented milk with added pulp guava, probiotic cultures and sweet whey (unsalted whey) resulted from Ras cheese manufacturing, (2) Access to the best ingredients between the two types of probiotic bacteria (*Lactobacillus aciophilus* and *Bifidobacterium bavidium*, and (3) Creating a mathematical model describing the relation between consumer acceptance degree and whey ratio at each starter.

II. METHODS AND MATERIAL

Materials:

Guava (Psidium guajava L.) pulps were obtained in a Masr Italia for food Industries at a factory of fruit pulp in Damietta El-Jadida city, Damietta Governorate, Egypt. Both fruit pulps were homogenized and repacked in low density polyethylene bags. One part of the samples was characterized according to moisture content, pH, acidity, ash and soluble solids (Table 1). The other part was stored in a freezer at the temperature of -18°C. until it was used in the experiments.

TABLE 1 PHYSCO-CHEMICAL COMPOSITION OF GUAVA PULP

pH	Acidity	Soluble solids	Black spaces	Color	Y&M	T.C
4.34	0.25	7.7	Non	Good	Nil	Nil

TABLE 2 CHEMICAL COMPOSITION IN COW'S MILK AND UNSALTED WHEY

	F (%)	F/DM (%)	TS (%)	pH value	Acidity
Cow's milk	3.50	29.12	12.02	6.71	0.16
Unsalted whey	0.80	10.66	7.50	6.14	0.14

	SNF (%)	Lactose (%)	Salt (%)	TP (%)
Cow's milk	8.52	4.32	--	3.41
Unsalted whey	6.15	4.22	0.05	1.1

Pasteurized milk (3.5% fat, 12.02% total solid content, 6.71 pH value and 3.41% total protein) obtained from dairy department, Faculty of Agriculture, Damietta University, Damietta, Egypt, and sweet Ras cheese (unsalted) whey (El-Ghazy laboratory, Elsawalem, Damietta), which was obtained during the production of Ras fresh cheese by the enzymatic coagulation process before the salting step (fat 0.80%, pH 6.14, total solids 7.50% and total protein 1.1%), heating to 65°C. to denatured of coagulation enzymes, were used to formulate the probiotic beverages (Table 2).

Starter culture (*Lactobacillus acidophilus* LA-5, *Bifidobacterium bavidium*) were obtained from Ch. Hansen's laboratories, Danmark. Sugar "Elmarwa" "white Sugar", Elmarwa Company for Treading& Distribution, Damietta, Egypt.

Processing of guava probiotic dairy beverage Formulations:

Twenty One beverages were formulated, containing 0 (control), 20, 35, 50, 65, and 80% (vol/vol) whey, with the remaining volume made up with milk, table (3). Preliminary experiments indicated that these whey concentrations were appropriate for sensory tests. Sugar was added to the probiotic beverage at a concentration of 10% (wt/vol) and the mixtures were heat-treated at 83°C for 15 min. After cooling the mixtures to 46°C, the

fruit "Guava pulp" preparation was added at 5% (wt/vol), the probiotic starter culture inoculum at 2% (vol/vol) (Table 3). The mixture was kept at 45°C for the fermentation process, which was stopped by cooling to 5-8°C. The beverages were stored under refrigeration until the consumer test.

TABLE 3 PROCESSING OF THE PROBIOTIC BEVERAGE FORMULATIONS EACH 1000 ML

Treatments	Milk (L.)	Whey (L.)	Whey (%)	Guava (ml)	Starter (ml)	Sugar (gm)	Total
T_1	830	----	0	50	20 ml *L. aciophilus*	100	1000
	664	166	20	50		100	1000
	539.5	290.5	35	50		100	1000
	415	415	50	50		100	1000
	290.5	539.5	65	50		100	1000
	166	664	80	50		100	1000
	----	830	100	50		100	1000
T_2	830	----	0	50	20 ml *B. bavidium*	100	1000
	664	166	20	50		100	1000
	539.5	290.5	35	50		100	1000
	415	415	50	50		100	1000
	290.5	539.5	65	50		100	1000
	166	664	80	50		100	1000
	----	830	100	50		100	1000
T_3	830	----	0	50	10 ml *L. aciophilus* + 10 ml *B. bavidium*	100	1000
	664	166	20	50		100	1000
	539.5	290.5	35	50		100	1000
	415	415	50	50		100	1000
	290.5	539.5	65	50		100	1000
	166	664	80	50		100	1000
	----	830	100	50		100	1000

T_1: Probiotic beverage with 2% *L. aciophilus*, **T_2**: Probiotic beverage with 2% *B. bavidium*, **T_3**: Probiotic beverage with 1% *L. aciophilus* and 1% *B. bavidium*

Physico-chemical and Microbiological Analyses:

Total solids (TS%), fat, total nitrogen (TN%), lactose content, soluble nitrogen (SN%) and non-protein nitrogen (NPN%) of milk and cheese samples were determined according to [16], the pH was determined with a digital pH meter (Hanna AT 4817). Salt contents of samples were estimated using Volhard method according to [17]. The titrable acidity of guava bulp was estimated by [18]. The Brix percentage of the guava pulp was determined using the refractometer to estimate soluble solids. Total bacterial count (T.C.) of Guava pulp was determined according to [19]. Yeast and Mold (Y&M) were determined to according [19].

The enumeration of *L. acidophilus* LA-5 was carried out in duplicate using de Man, Rogosa, and Sharpe agar supplemented with 0.15% (wt/vol) of bile salts obtained from (El-Gomhoria co., Mansoura, Egypt), incubating anaerobically for 3 days at 37°C [20]. Live strain in *B. bavidium* was inoculated in (MRS) broth supplemented with 0.05% (w/v) cysteine hydrochloride at 37°C under anaerobic conditions for 24 h [19]. Colifom bacteria count according to the method described by [19].

Mathematical Modelling:

Curve expert© 1.3 program was used to model the relationship between the product quality (Independent variable) and whey ratio (dependent variable) for the three types of starter. The average of whey treatments for the three types of starter were used to fit the curve of the consumer acceptance degree which describes product quality. Sinusoidal fit was resulted with a correlation factor 98.59%. Referring to the previous result the sinusoidal fit was chosen to fit the curves which describe the relationship between the product quality and whey ratio at each starter type. Each curve will be fitted to model consumer acceptance degree (C) as a function of whey ratio (W).

Statistical Analysis:

Data were analyzed using [21] computer program, GLM analysis of variance (ANOVA). Differences between means were detected by Duncan's Multiple Range Test [22].

Consumer Test:

Thirty consumers "staff members, graduate and undergraduate students, workers and employees of

Faculty of Agriculture, Damietta University, Egypt" were randomly selected and invited to take part in the test [23]. The samples were presented at 5±3°C, served in polystyrene cups coded with 3-digit numbers, following the sample presentation design in balanced complete blocks [24] aimed at decreasing the carryover and first-order effects, served 30-50 ml samples to each consumer. Participants were instructed to drink water between samples to cleanse the palate. They evaluated the samples acceptance using a 9-point hybrid hedonic scale [25], where 1 = disliked extremely, and 9 = liked extremely. The consumer test was carried out after samples refrigerated.

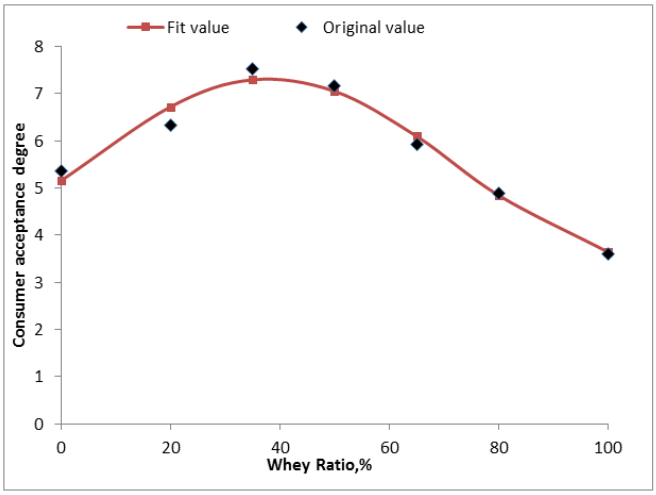


Figure 1 : Fitting of Whey ratio- consumer acceptance degree curve

III. RESULTS AND DISCUSSION

pH and Microbiological Values:

Based on the results, we concluded that the beverages met the standards for human consumption according to the Egyptian legislation, thus allowing their use in sensory tests. Table (4) shows the pH values, *L. acidophilus* and *B. bavidium* counts in whey probiotic beverages. The pH values varied from 4.083±0.009 to 5.173±0.012, the highest pH values (5.039±0.013 to 5.173±0.012) when the treatments using of *B. bavidium* T_2 treatments", while the less values (4.083±0.009 to 4.246±0.020) in the using of *L. acidophilus* "T_1 treatments", but in treatments using L. acidophilus and *B. bavidium* "T_3 treatments" were a medium values (4.313±0.049 to 4.627±0.012). From the first experiment "T_1 treatments" that included the *L. aciophilus* as a starter, only. It's clear that adding whey during the different stages from 0% up to 100% had highly significant ($p<0.001$) effect on the values of pH and *L. aciophilus* starter. pH values were at range from 4.086±0.009 (20%, whey) to 4.246±0.020 (100%, whey), while the counts of starter were at range from 29.333±0.882 $X10^5$ (100%, whey) to 57.333±0.333 X105 (20%, whey). Also, in the second experiment "T_2 treatments", the effect of adding whey on the pH values and counts of *B. bavidium* $X10^6$ starter was found to be highly significant ($p\leq0.001$). Higher value of pH and counts of *B. bavidium* was recorded as 5.173±0.012 (100%, whey) and 87.000±1.732 $X10^6$ (0%, whey), respectively, while the lower value was 5.039±0.013 (0%, whey) and 70.333±4.631 $X10^6$ (100%, whey), respectively. On the other hand, the third experiment "T_3 treatments" included both of *L. aciophilus* and *B. bavidium* as starters. Adding whey during the different stages had highly significant effect ($p<0.001$) on pH values and *L. aciophilus* starter, pH values ranged from 4.313±0.049 (100%, whey) to 4.627±0.012 (65%, whey), while the values of *L. aciophilus* Starter ranged from 5.667±1.333 $X10^5$ (65%, whey) to 21.667±4.055 $X10^5$ (0%, whey), in contrast; non-significant effect ($p=0.609$) of adding whey was showed on *B. bavidium* $X10^6$ starter. With respect to *L. acidophilus* count, all beverages presented values>8 log cfu/ml, indicating a probiotic level sufficient to provide consumer benefits and to compensate a possible reduction caused by passage through the gastrointestinal tract [26]. In accordance with Egyptian legislation, the whey beverages showed probiotic counts >7 cfu/100 ml of product. The whey content did not interfere in the viability of probiotics in the dairy beverages ($p>0.05$), indicating no limit in the capacity of the probiotic strain to metabolize the peptides present in the whey. These results confirmed the technological application of fresh whey from Minas Frescal cheese as a means to develop probiotic bacteria [27]. Moreover, our findings were comparable to those of other studies involving dairy beverages [28] and to results obtained for other dairy products processed from cheese whey [29 and 30] and other dairy foods, such as yogurts [31], cheese [32 and 33], and ice cream [34 and 35]. All samples were free counts of yeasts and molds and coliforms may be the hygienic or sanitary conditions during the process.

Consumer Test:

Table 5 shows the acceptance of the probiotic whey beverages containing different levels of whey in three experiments "T_1, T_2 and T_3 treatments". The lower value (5.000±0.179) of the consumer acceptance of guava

probiotic dairy beverages with different whey contents in the first experiment "T_1 treatments" was showed at 0% and 80%, whey, while higher value was 7.267±0.117 at 35%, whey. In the second T_2 treatments" and third "T_3 treatments" experiment lower value of consumer acceptance (3.233±0.213 and 3.867±0.150, respectively) was recorded at 100%, whey, while higher value was 7.567±0.092 and 7.767±0.104, respectively at 35%, whey.

Whey content had an effect on consumer acceptance ($p<0.05$): maximum acceptance was observed for the beverage with 35% whey (mean score of 7.0 on the 9-point hedonic scale). Greater amounts of whey resulted in lower consumer acceptance: samples with 65 and 80% whey presented mean scores of 5.7 and 5.2, respectively [36]. This results was agreement of [37 and 38]. Previous studies reported the use of survival analysis in development of dairy products. [39] used survival analysis to estimate the shelf life of probiotic yogurts. The consumer acceptance indicated values of 35% and 50% whey in the formulations, respectively. Nevertheless, considering the elevated nutritional quality of the whey, the need to reduce the costs of the formulation, and the need to minimize the emission of polluting substances, the use of cheese whey meets the needs of the food industry.

An analysis of the results presented by the different mathematical modelling allowed for the selection of two probiotic beverage formulations: the first, determined by analysis of the consumer acceptance degree, contained 0 to 100% cheese whey in its formulation, and the second, determined by the best consumer acceptance degree, contained 35 and 50% unsalted whey, respectively.

Figure (2) describes the deviation between sensor degree and resulted values of models. Standard error of the three models varied between 0.38 and 0.40 which means the predicted values is close to the experimental obtained values [40] Cosine function has the property of describing the behavior of a curve that describes a relationship has the trends of both decrease and increase [41].

Thus, we tried to create a mathematical modelling to describe the relation between the consumer's acceptance degree and whey-added ratio for both types of starters, while meeting current demands of the dairy industry.

TABLE 4 PH VALUES AND PROBIOTIC MICROBIAL COUNTS (LOG CFU/ML; MEANS±SD) OF GUAVA PROBIOTIC DAIRY BEVERAGES WITH DIFFERENT WHEY CONTENTS

Whey (%)	**pH**	L. aciophilus **X 10^5**	B. bavidium **X 10^6**
T_1			
0	4.093±0.009^{cd}	54.333±1.202^{a}	-
20	4.086±0.009^{d}	57.333±0.333^{a}	-
35	4.160±0.012^{b}	45.333±0.333^{b}	-
50	4.096±0.009^{cd}	44.333±1.453^{cb}	-
65	4.126±0.012^{cb}	39.667±2.906^{c}	-
80	4.083±0.009^{d}	58.333±2.603^{a}	-
100	4.246±0.020^{a}	29.333±0.882^{d}	-
P-value	**<0.001**	**<0.001**	-
T_2			
0	5.039±0.013^{d}	-	87.000±1.732^{a}
20	5.080±0.012^{d}	-	85.667±2.963^{a}
35	5.160±0.006^{ab}	-	81.333±2.333^{ab}
50	5.107±0.009^{cd}	-	79.000±1.732^{abc}
65	5.133±0.009^{cb}	-	74.333±2.963^{bc}
80	5.093±0.009^{d}	-	73.667±2.333^{bc}
100	5.173±0.012^{a}	-	70.333±4.631^{c}
P-value	**<0.001**	-	**<0.001**
T_3			
0	4.337±0.022^{d}	21.667±4.055^{a}	32.333±1.202
20	4.450±0.031^{c}	18.333±2.333^{ab}	33.667±1.764
35	4.550±0.021^{ab}	15.667±1.333^{abc}	29.667±1.202
50	4.530±0.025^{cb}	10.333±1.202^{cd}	31.333±4.910

65	4.627±0.012[a]	5.667±1.333[d]	35.333±3.756
80	4.550±0.025[ab]	18.333±1.202[ab]	30.333±2.603
100	4.313±0.049[d]	11.667±1.202[bcd]	28.333±1.453
P-value	**<0.001**	**<0.001**	**0.609**

T_1: Probiotic beverage with 2% *L. aciophilus*, **T_2**: Probiotic beverage with 2% *B. bavidium*, **T_3**: Probiotic beverage with 1% *L. aciophilus* and 1% *B. bavidium*

TABLE 5 AVERAGE CONSUMER ACCEPTANCE OF GUAVA PROBIOTIC DAIRY BEVERAGES WITH DIFFERENT WHEY CONTENTS

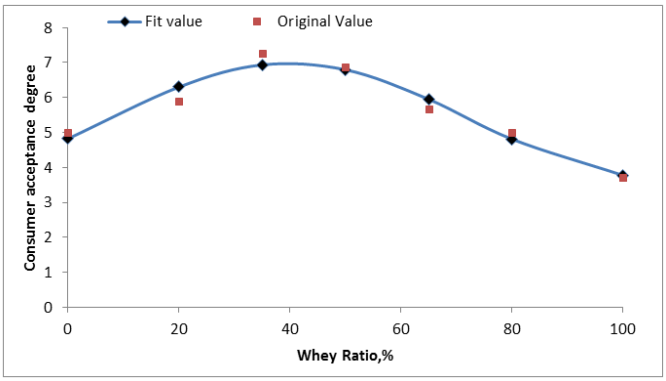
Whey (%)	0	20	35	50	65	80	100
T_1	5.000±0.179	5.900±0.139	7.267±0.117	6.867±0.115	5.667±0.130	5.000±0.179	3.700±0.204
T_2	5.367±0.169	6.367±0.122	7.567±0.092	7.033±0.102	5.867±0.115	5.233±0.149	3.233±0.213
T_3	5.700±0.174	6.700±0.137	7.767±0.104	7.633±0.162	6.233±0.133	4.467±0.124	3.867±0.150

***** **T_1**: Probiotic beverage with 2% *L. aciophilus*, **T_2**: Probiotic beverage with 2% *B. bavidium*, **T_3**: Probiotic beverage with 1% *L. aciophilus* and 1% *B. bavidium*
** Evaluated on a 9-point hybrid hedonic scale from 1 = disliked extremely to 9 = liked extremely.

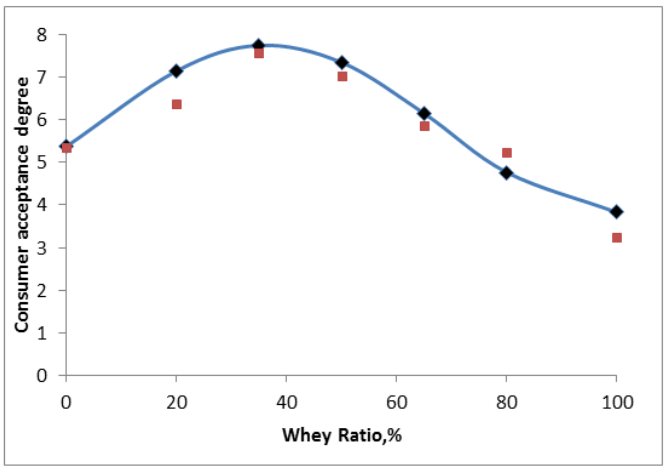
TABLE 6 MATHEMATICAL MODELLING OF CONSUMER ACCEPTANCE DEGREE AS A FUNCTION OF WHEY RATIO

Starter	Formula	Correlation factor, %	Standard error
T_1	C=5.3444539+1.635956*cos(0.047459805W-1.8955734)	97.53	0.38
T_2	C=-27.949858+35.123374*cos(0.010003013W-0.49273582)	98.16	0.40
T_3	C=5.7246037+2.5126344*cos(0.063559216W-2.7262609)	98.14	0.38

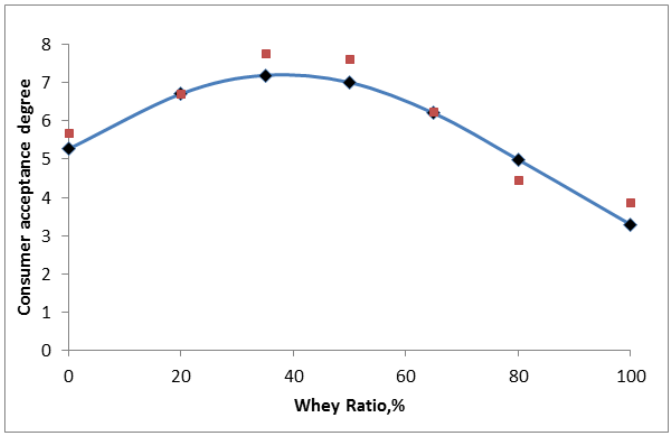
T_1: Probiotic beverage with 2% *L. aciophilus*, **T_2**: Probiotic beverage with 2% *B. bavidium*, **T_3**: Probiotic beverage with 1% *L. aciophilus* and 1% *B. bavidium*
C: The consumer acceptance degree, **W:** whey ratio percentage interchangeably with cow's milk



A



B



C

Figure 2: Curve fitting of consumer acceptance degree as a function of whey ratio at three types of starters A) T1 B) T2 C) T3

IV.CONCLUSION

pH values in whey probiotic beverages between 4.083±0.009 to 5.173±0.012, the highest pH recorded in T_2 treatments, while the less values in T_1 treatments, but in T_3 treatments were a medium values.

- Higher numbers of *B. bavidium* in beverages were recorded as 87.000±1.732 $X10^6$ (0%, whey), while the lower numbers were 70.333±4.631 $X10^6$ (100%, whey). On the other hand, the numbers of *L. aciophilus* ranged from 5.667±1.333X105 (65%, whey) to 21.667±4.055 $X10^5$ (0%, whey).

- The lower value (5.000±0.179) of the consumer acceptance of beverages in T_1 treatments were showed at 0% and 80%, whey, while higher value was 7.267±0.117 at 35%, whey. In T_2 and T_3 treatments recorded lower value of consumer acceptance (3.233±0.213 and 3.867±0.150, respectively) at 100%, whey, while higher value were 7.567±0.092 and 7.767±0.104, respectively at 35%, whey.
- In attempt to create a mathematical modelling to describe the relation between the consumer's acceptance degree and whey-added ratio for both types of starters, while meeting current demands of the dairy industry, we created a mathematical models listed.
- Generally, the whey content had an effect on consumer acceptance ($p<0.05$): maximum acceptance was observed for the beverage with 35% whey.

V. REFERENCES

[1] Cheng, J.T. and Yang, R.S. 1983. Hypoglycemic effect of guava juice in mice and human subjects. *American Journal of Chinese Medicine* (11), 74-76. Print ISSN: 0192-415X, Online ISSN: 1793-6853, http://dx.doi.org/10.1142/S0192415X83000124

[2] Smith, R.M. and Siwatibau, S. 1975. Sesquiterpene hydrocarbons of Fijian guavas, Phytochemistry, 14 (9), September 1975, 2013-2015, ISSN 0031-9422, http://dx.doi.org/10.1016/0031-9422(75)83115-3

[3] Macleod, A.J. and Troconis, N.G. 1975. Volatile flavour components of guava, *Phytochemistry*, (21), 1339-42. ISSN 0031-9422, http://dx.doi.org/10.1016/0031-9422(82)80138-6

[4] Geidam, Y.A., Ambali, A.G. and Onyeyili, P.A. 2007. Phytochemical screening and antibacterial properties of organic solvent fractions of Psidium guajava aqueous leaf extracts, International Journal of Pharmacology, 3 (1), 68-73. ISSN: 2454-2172

[5] Bassols, F. and Demole, E.P. 1994. The occurrence of pentane-2-thiol in guava fruit. *Journal of Essential Oil Research*, 6(5), 481-483. ISSN: 1041-2905 http://dx.doi.org/10.1080/10412905.1994.9698430

[6] Thaipong, K., Boonprakob, U., Crosby, K., Cisneros-Zevallos, L. and Byrne, D.H. 2006. Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from guava fruit extracts. *Journal of Food Composition and Analysis*, 19 (6–7), 669–675. ISSN: 0889-5175 http://dx.doi.org/10.1016/j.jfca.2006.01.003

[7] Imungi, J.K., Schefield, H. and Saint-Hilslare, U. 1994. Physical-chemical changes during extraction and clarification of guava juice. *Chemistry and Technology*, (7), 33-41.

[8] Anil Kumar Chauhan, Smita Singh, Ravi Pratap Singh and Singh, S.P. 2015. Guava-enriched dairy products: a review. *Indian J. Dairy Sci.* 68(1), 1-5. ISSN: 2454-2172

[9] Singh, W., Kapoor, C.M. and Srivastava, D.N. 1999. Technology for the manufacture of guava- whey beverage. *International Journal of Dairy Science*, (52), 268-270. eISSN: 1811-9751, pISSN: 1811-9743.

[10] Divya, Kumari, A. 2009. Effect of Different Temperatures, Timings and Storage Periods on the Physico-Chemical and Nutritional Characteristics of Whey-Guava Beverage. *World Journal of Dairy and Food Sciences*, 4(2), 118-122. ISSN: 1817-308X, EISSN: 2078-4627.

[11] FAO/WHO, 2001. Health and nutritional properties of probiotics in food including powder milk with live lactic acid bacteria. Report of a Joint FAO/WHO Expert Consultation, Geneva, Switzerland.

[12] Gibson G.R. and Roberfroid M.B. 1995. Dietary modulation of the human colonic microbiota: Introducing the concept of prebiotics. *Journal of Nutrition*, (125), 1401–1412. Print ISSN: 0022-3166, Online ISSN: 1541-6100

[13] International Scientific Association for Probiotics and Prebiotics (ISAPP) 2009. Prebiotics: A consumer guide for making smart choices. *http://www.isapp.net/docs/Consumer_Guidelines-prebiotic.pdf.*

[14] Collins, M.D. and Gibson, G.R. 1999. Probiotics, prebiotics, and synbiotics: approaches for modulating the microbial ecology of the gut. *Am. J. Clin. Nutr.* (69), 1052S–1057S. Print ISSN: 0002-9165, Online ISSN: 1938-3207

[15] Boumba, V.A., Voutsinas, L.P. and Philippopoules, C.D. 2001. Composition and nutritional value of commercial dried whey products from Feta cheese manufacture. *International Journal of Dairy Technology*, 54(4), 141-145. ISSN: 1364-727X http://dx.doi.org/10.1046/j.1364-727x.2001.00026.x

[16] AOAC 2012. Association of official analytical chemists, Official methods of analysis, 19th (Ed), Vol (2), Arlington VA.USA

[17] Richardson G.H. 1985. Standard Methods of the Examination of Dairy Products.15th Ed. American Public Health Assocition. Washington, DC

[18] Ranganna, S. 1986. Hand book of analysis and quality control for fruits and vegetables products. Tata Mc Graw Hill Publishing Co Ltd, New Delhi, India.

[19] APHA, American Public Health Association, 1998. Standard Methods for the Examination of Water and Wastewater, 20th Ed., Inc. New York.

[20] Mortazavian, A.M., Ehsani, M.R., Mousavi, S.M., Sohrabvandi, S., Reinheimer, J.A. (2006) Combined effects of temperature-related variables on the viability of probiotic micro-organisms in yogurt. *Aust. J. Dairy Technol.*, 61:248–252. ISSN: 0004-9433

[21] SAS 2004. Version 90 SAS Institute Inc Cary NC.

[22] Duncan, D.B. 1955. Multiple Range and Multiple F-test. Biometrics, (11), 1– 42.

[23] Hough, G., M. L. Calle, C. Serrat, and A. Curia. 2007. Number of consumers necessary for shelf life estimations based on survival analysis statistics. Food Qual. Prefer. 18:771–775. ISSN: 0950-3293 http://dx.doi.org/10.1016/j.foodqual.2007.01.003

[24] MacFie, H.J., Bratchell, N., Greenhoff, K. and Vallus, L.V. 1989. Designs to balance the effect of order of presentation and first-order carry-over effects in hall tests. *J. Sens. Stud.*, 4:129–148. ISSN: 0887-8250 http://dx.doi.org/10.1111/j.1745-459X.1989.tb00463.x

[25] Drake, M.A. 2007. Invited Review: Sensory Analysis of Dairy Foods. *J. Dairy Sci.*, 90:(11), 4925–4937. ISSN: 0022-0302 http://dx.doi.org/10.3168/jds.2007-0332

[26] Granato, D., Branco, G.F., Cruz, A.G., Faria, J.A.F. and Shah, N.P. 2010. Probiotic dairy products as functional foods. *Comp. Rev. Food Sci. Saf.*, 9:455–470. ISSN: 1541-4337 http://dx.doi.org/10.1111/j.1541-4337.2010.00120.x

[27] Almeida, R.A., Luther, D.A., Park, H.M. and Oliver, S.P. 2006. Identification, isolation, and partial characterization of a novel *Streptococcus uberis* adhesion molecule (SUAM). *Vet. Microbiol.*, 115:183–191. ISSN: 0378-1135 http://dx.doi.org/10.1016/j.vetmic.2006.02.005

[28] Madureira, A.R., Tavares, T., Gomes, A.M.P., Pintado, M.E. and Malcata, F.X. 2010. Invited review: Physiological properties of bioactive peptides obtained from whey proteins. *J. Dairy Sci.*, 93:437–455. ISSN: 0022-0302 http://dx.doi.org/10.3168/jds.2009-2566

[29] Madureira, A.R., Pereira, C.I., Gomes, A.M.P., Pintado, M.E. and Malcata, F.X. 2007. Bovine whey proteins—Overview on their main biological properties. *Food Res. Int.*, 40:1197–1211. ISSN: 0963-9969.

[30] Madureira, A.R., Amorim, M., Gomes, A.M., Pintado, M.E. and Malcata, F.X. 2011. Protective effect of whey cheese matrix on probiotic strains exposed to simulated gastrointestinal conditions. *Food Res. Int.*, 44:465–470. ISSN: 0963-9969. http://dx.doi.org/10.1016/j.foodres.2010.09.010

[31] Cruz, A.G., Cadena, R.S., Faria, J.A.F., Bolini, H.M.A., Dantas, C., Ferreira, M.C.C. and Deliza, R. 2012. PARAFAC: Adjustment for modeling consumer study covering probiotic and conventional yogurt. *Food Res. Int.*, 45:211–215. ISSN: 0963-9969. http://dx.doi.org/10.1016/j.foodres.2011.09.031

[32] Gomes, A.A., Braga, S.P., Cruz, A.G., Cadena, R.S., Lollo, P.C.B., Carvalho, C., Amaya-Farfan, J., Faria, J.A. and Bolini, H.M. 2011. Effect of the inoculation level of *Lactobacillus acidophilus* in probiotic cheese on the physicochemical features and sensory performance compared with commercial cheeses. *J. Dairy Sci.*, 94:4777–4786. ISSN: 0022-0302 http://dx.doi.org/10.3168/jds.2011-4175

[33] Escobar, M.C., Van Tasseli, M.L., Martínez-Bustos, F., Castaño-Tostado, E., Amaya-Llano, S.L. and Miller, M.J. 2012. Characterization of a Panela cheese with added probiotics and fava bean starch. *J. Dairy Sci.*, 95:2779–2787. ISSN: 0022-0302 http://dx.doi.org/10.3168/jds.2011-4655

[34] Di Criscio, T., Fratianni, A., Mignogna, R., Cinquanta, L., Coppola, R., Sorrentino, E. and Panfili, G. 2010. Production of functional probiotic, prebiotic, and synbiotic ice creams. *J. Dairy Sci.*, 93:4555–4564. ISSN: 0022-0302 http://dx.doi.org/10.3168/jds.2010-3355

[35] Ferraz, J.L., Cruz, A.G., Cadena, R.S., Freitas, M.Q., Pinto, U.M., Carvalho, C.C., Faria, J.A.F. and Bolini, H.M.A. 2012. Sensory acceptance and survival of probiotic bacteria in ice cream produced with different overrun levels. *J. Food Sci.*, 77:S24–S28. Online ISSN: 1750-3841 http://dx.doi.org/10.1111/j.1750-3841.2011.02508.x

[36] Castro, W.F., Cruz, A.G., Bisinotto, M.S., Guerreiro, L.M.R., Faria, J.A.F., Bolini, H.M.A., Cunha, R.L. and Deliza, R. 2013. Development of probiotic dairy beverages: Rheological properties and application of mathematical models in sensory evaluation. *J. Dairy Sci.*, (96), 16–25. ISSN: 0022-0302 http://dx.doi.org/10.3168/jds.2012-5590

[37] Beecher J. W., M. A. Drake, P. J. Luck, and E. A. Foegeding 2008. Factors Regulating Astringency of Whey Protein Beverages. *J. Dairy Sci.* 91:2553–2560. ISSN: 0022-0302 http://dx.doi.org/10.3168/jds.2008-1083

[38] Vardhanabhuti B., M.A. Kelly, P.J. Luck, M.A. Drake and E.A. Foegeding (2010). Roles of charge interactions on astringency of whey proteins at low pH. *J. Dairy Sci.*, 93:(5), 1890–1899. ISSN: 0022-0302. http://dx.doi.org/10.3168/jds.2009-2780

[39] Cruz A.G., J.A.F. Faria, E.H.M. Walter, R.R. Andrade and R.N. Cavalcanti, C.A.F. Oliveira, D. Granato (2010). Processing optimization of probiotic yogurt containing glucose oxidase using response surface methodology, *J. Dairy Sci.*, 93(11), 5059–5068. ISSN: 0022-0302 http://dx.doi.org/10.3168/jds.2010-3336

[40] Payton, M.E., Greenstone, M.H. & Schenker, N. (2003). Overlapping confidence intervals or standard error intervals: what do they mean in terms of statistical significance? *Journal of Insect Science*, (3) 34, 1-6. ISSN: 0970-3837 http://dx.doi.org/10.1673/031.003.3401

[41] Strang, G. (1986). Introduction to applied mathematics. *Wellesley-Cambridge Press*, Wellesley, Mass.