



Study of the composition of mango pulp and whey for lactic fermented beverages

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INFO

Keywords

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ABSTRACT

Fermented lactic beverages have high sensory acceptance and may present probiotic microorganisms that are able to promote well-being. Milk is the primary substrate for this type of fermentation. However, more and more, consumers have been requesting for alternative formulations with lower (or absent) milk content. Two nutritional components can allow the reduction of milk in formulations: cheese whey (CW) and fruit pulps. This study aimed to investigate, with the aid of the experimental design tool and sensory analysis, the best formulations between mango pulp (MP), CW and whole milk (WM) to develop lactic beverages fermented by *Lactobacillus acidophilus* La-5 at 37 °C for up to 72 h. The results indicated that the increase in MP proportion associated with a decrease in WM elevated the sensory acceptance. Three formulations, with 24 h of fermentation, containing 55 – 100 % (w/w) of MP and 0 – 45 % (w/w) of CW were the best formulations and presented pH of 3.5 – 4.0, cell count >10⁸ CFU/mL and 82 – 88 % of global acceptance. These results suggest MP or MP with CH as substrates for lactic fermentation replacing milk.

RESUMO

Estudo da composição de polpa de manga e soro de queijo para bebidas lácticas fermentadas. As bebidas lácticas fermentadas apresentam alta aceitação sensorial e podem conter microrganismos probióticos que são capazes de promover o bem-estar. O leite é a principal matéria-prima para esse tipo de fermentação. No entanto, cada vez mais, os consumidores vêm solicitando formulações alternativas com menor composição (ou ausência) de leite. Dois componentes nutritivos podem permitir a redução do leite nas formulações: o soro de queijo (SQ) e polpas de fruta. Assim, este trabalho teve como objetivo investigar, com o auxílio da ferramenta de planejamento experimental e análise sensorial, as melhores formulações entre polpa de manga (PM), SQ e leite integral (LI) para o desenvolvimento de bebidas lácticas fermentadas por *Lactobacillus acidophilus* La-5 a 37 °C por até 72 h. Os resultados indicaram que o aumento da proporção de PM associado a diminuição de LI elevou a aceitação sensorial. Três formulações, com 24 h de fermentação, contendo 55 – 100 % (p/p) de PM e 0 – 45 % (p/p) de SQ foram as melhores formulações e apresentaram pH de 3,5 – 4,0, contagem de células >10⁸ UFC/mL e 82 – 88 % de aceitação global. Esses resultados sugerem PM ou PM com SQ como substratos para a fermentação láctica em substituição ao LI.

Palavras-chaves

fermentação
polpa de fruta
bactérias do ácido láctico
Mangifera indica
matriz de mistura

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INTRODUCTION

Lactic acid bacteria (LAB) are industrially important microorganisms and are used in industrial food fermentations, such as: yogurt (Huang et al., 2020), fermented milk (Abdel-Hamid et al., 2019), soy (Peirotén et al., 2020) and fruits (Isas et al., 2020). LAB are usually found in milk and dairy products, in plants and in the human and animal intestinal mucosa (Yerlikaya et al., 2020); they are capable of metabolizing different substrates and to improve nutritional properties (Garcia et al., 2020a). In addition, they are able to modify the profile of bioactive compounds and some physical-chemical and sensory characteristics besides to reduce lactose content and extend the shelf life by increasing acidity or producing bacteriocins (Daba and Elkhateeb, 2020; Wu et al., 2021). This group of bacteria has gained prominence due to the great potential to be used as probiotics (Peng et al., 2020). Among the various groups of bacteria classified as LAB, the most studied are *Lactobacillus bulgaricus*, *Streptococcus thermophilus* and *Bifidobacteria* spp. that are used industrially to produce yogurt (Yerlikaya et al., 2020).

The main raw material for lactic fermentation is milk (Peng et al., 2020), however, whey has been increasingly studied and applied for different fermented beverages (Guimarães et al., 2019). Whey is one of the main by-products of the cheese industry and is a source of vitamins, minerals and proteins such as sulphur amino acids which are particularly valuable due to their anticarcinogenic activities (Moussa and El-Gendy, 2019). Whey can contain approximately half the total amount of milk solids (e.g. proteins, lactose and mineral) and is estimated to be equivalent to 90 % of milk volume. However, if disposed of incorrectly, it can be an environmental threat due to its high organic loads (Rama et al., 2019).

Another rich substrate for LAB fermentation can be suggested as different tropical fruit pulps (or juices) such as: *Spondias dulcis* (Souza et al., 2020a), *Theobroma grandiflorum* (Pereira et al., 2017), *Syzygium cumini* (Garcia et al., 2020b), *Anacardium occidentale* (Souza et al., 2020b) and many others. Fruit pulps can be potential substrates due to the incorporation of specific aromas (which improves sensory acceptance) and some specific nutrients. Furthermore, the fruit based fermented products are lactose free, which meet the needs of consumers with lactose intolerance, for example (Maldonado et al., 2017). Mango (*Mangifera indica*) is one of the tropical fruits with unique flavor and high nutritional value; some works were performed previously with mango and whey, for example: Andrade et al. (2019), Skyplonek et al.

(2019), Pandey and Ojha (2020) and Pandey et al. (2019). This study targeted the production of lactic fermented beverages based on mango, milk and whey. The fermentation conditions, and the physical-chemical, sensory and microbiological characteristics of the finished products were also investigated.

MATERIAL AND METHODS

Preparation of mango pulp, milk and whey

The mangoes utilized (*Magnifica indica* v. Tommy Atkins) were purchased locally (Mogi Guaçu, São Paulo, Brazil). The fruits were cleaned, peeled, and processed in a blender for the pulp preparation at the proportion 1:1 (mango pulp mass / distilled water mass). The pulp was pasteurized in batches (80 °C / 5 min), hot filled in glass flasks, cooled to ambient temperature (~25 °C) and then frozen at -18 °C (Maldonado et al., 2017; Nagpal et al., 2012).

Whey was obtained from the coagulation of whole fresh (unpasteurized) milk also supplied by a local producer. The coagulation process was realized with the addition of a lactic culture (10^6 UFC/mL, Rhodia Foods®) and rennet (Estrella®). After one hour of coagulation, the whey was separated by filtration, pasteurized, and stored under the same conditions as the mango pulp. The whole milk was pasteurized and stored under the same conditions as the mango pulp and whey (Maldonado et al., 2017).

Lactic fermentation

The formulation of mango, milk, and whey-based lactic fermented beverages was evaluated using a Simplex Mixture Design for three components with ten different formulations (trials) (Bourscheid et al., 2014; Barros Neto et al., 2010). The minimum quantities of mango pulp and whey were defined at 40 % and 30 % (w/w), respectively, based on a previous study (Maldonado et al., 2017). The statistical analysis was performed with STATISTICA v.8 (Statsoft).

The fermentations were conducted in sterilized flasks of 250 mL, into which 150 mL of the substrates were added. A lyophilized lactic culture (LAB) containing *Lactobacillus acidophilus* La-5 (10^6 UFC/mL) was inoculated into each flask. The flasks were still kept at 37 °C without agitation for 72 h. Samples were collected every 24 h for assessing the titratable acidity, concentration of soluble solids (SS), and pH. All formulations from the mixture design with 24 h of fermentation were selected for LAB cells counting (dilution 10^{-8}) and sensorial analysis.

Two formulations were then selected from the

data analysis: trial 1 [70 % (w/w) of mango and 30 % (w/w) of whey] and trial 4 [55 % (w/w) of mango and 45 % (w/w) of whey). A sample containing 100 % (w/w) of mango was also taken. They were all fermented (5 replicates) for 24 h and were sensory evaluated.

Analytical methods

Physico-chemical analysis: The physico-chemical tests were carried out according to the standards described by the Instituto Adolfo Lutz (IAL, 2005). For the determination of acidity titration was performed with a NaOH 0.1 mol/L and phenolphthalein; the soluble solids content (SS, °Brix) was measured with a portable refractometer (Instrumentep, São Paulo, Brazil) and the pH with a digital pHmeter (Digimed, São Paulo, Brazil).

Microbiological analysis: The LAB cell counting was performed by the colony forming units (CFU) method with serial decimal dilution of samples and plating (triplicate) in MRS (Man, Rogosa and Sharpe, Kasvi®, Brazil) agar with incubation at 37 °C / 48 h (Fujita et al., 2017; Maldonado et al., 2017). Values were expressed per volume of fermented beverages (CFU/mL).

Sensory analysis: Based on previous work (Nogueira et al., 2016; Santos et al., 2008) and with approval of the Ethics Committee (CAAE n. 56661716.8.0000.5679), the sensory evaluation of the fermented beverages was conducted with untrained assessors. The attributes taste, aroma, color and overall acceptance were evaluated using a five-point just-about-right (JAR) scale (5 = liked very much and 1 = disliked very much). Sweetness

and acidity were assessed with a five-point ideality scale (5 = much higher than the ideal and 1 = much lower than the model). The samples were produced accordingly to the good manufacturing practices and stored for one day in a fridge; prior to analysis, the samples were sweetened with 10 % (w/v) of sucrose to balance the acid/sweet ratio. For the first stage of analysis, ten selected formulations were evaluated by 15 untrained assessors and, for the second stage, three selected formulations were assessed by 58 untrained assessors. The results were evaluated by ANOVA and Tukey test, with a confidence level of 95 % ($p < 0.05$).

RESULTS AND DISCUSSION

Lactic Fermentation

The mango pulp, whey and milk-based lactic beverages were prepared according to the proportions defined by the matrix design shown in Table 1. The obtained profiles for: pH, acidity (% v/v) and soluble solids (SS, °Brix) throughout the 72 h of fermentation (Fig. 1) demonstrate that the fermentation process, in the first 24 h, resulted in abrupt decreases for pH and SS values but for the titratable acidity it was observed a continuous increase until the end of the 72 h of fermentation. The lactic acid, the main acid produced by LAB, is a weak acid and its increase in time, does not necessarily reflect a significant decrease of pH, since it can may generate a buffering effect which tends to minimize the pH variations (Maldonado et al., 2017).

Table 1 - Coded Simplex Matrix with pseudo-components to evaluate the formulation of lactic fermented beverages with mango pulp, whey and milk. The responses presented are: cell count for lactic acid bacteria (LAB, log CFU/mL) and the average score for some sensorial attributes ($n = 15$ assessors). The real proportions (% w/w) of the variables are exhibited in parentheses

Trial	Variables			Responses (24 h)						
	Mango (% w/w)	Whey (% w/w)	Milk (% w/w)	LAB (log CFU/mL)	Taste	Aroma	Color	Overall Acceptance	Sweetness	Acidity
1	1 (70)	0 (30)	0 (0)	6.4	4.2 ± 0.5	2.9 ± 1.3	4.6 ± 0.5	4.2 ± 0.5	3.2 ± 0.4	2.9 ± 0.2
2	0 (40)	1 (60)	0 (0)	8.0	3.2 ± 0.9	2.9 ± 1.2	4.1 ± 0.8	3.2 ± 0.9	2.5 ± 0.7	2.8 ± 0.8
3	0 (40)	0 (30)	1 (30)	14.6	2.7 ± 1.0	3.1 ± 1.1	3.2 ± 1.2	2.4 ± 1.0	2.1 ± 0.7	2.9 ± 1.1
4	1/2 (55)	1/2 (45)	0 (0)	> 100 est.	4.4 ± 0.5	3.1 ± 1.1	4.5 ± 0.5	4.3 ± 0.6	3.1 ± 0.6	3.1 ± 0.4
5	1/2 (55)	0 (30)	1/2 (15)	13.4	2.9 ± 0.9	3.8 ± 1.1	3.7 ± 0.9	3.3 ± 0.9	2.6 ± 0.6	3.0 ± 0.8
6	0 (40)	1/2 (45)	1/2 (15)	> 100 est.	2.9 ± 1.0	3.6 ± 1.0	2.8 ± 1.2	3.1 ± 1.2	2.8 ± 0.6	3.4 ± 0.5
7	1/3 (50)	1/3 (40)	1/3 (10)	11.3	3.7 ± 0.7	3.1 ± 1.4	3.8 ± 0.8	3.7 ± 0.9	3.1 ± 0.4	3.1 ± 0.2
8	2/3 (60)	1/6 (35)	1/6 (5.0)	> 100 est.	4.1 ± 0.4	3.9 ± 0.8	4.3 ± 0.5	3.7 ± 0.5	2.9 ± 0.6	3.1 ± 0.5
9	1/6 (45)	2/3 (50)	1/6 (5.0)	> 100 est.	2.9 ± 0.7	3.0 ± 1.1	3.3 ± 0.8	3.0 ± 0.8	2.8 ± 0.8	2.8 ± 0.7
10	1/6 (45)	1/6 (35)	2/3 (20)	2.8	3.6 ± 0.7	3.3 ± 0.8	3.3 ± 0.9	3.3 ± 0.7	3.1 ± 0.7	2.7 ± 0.6

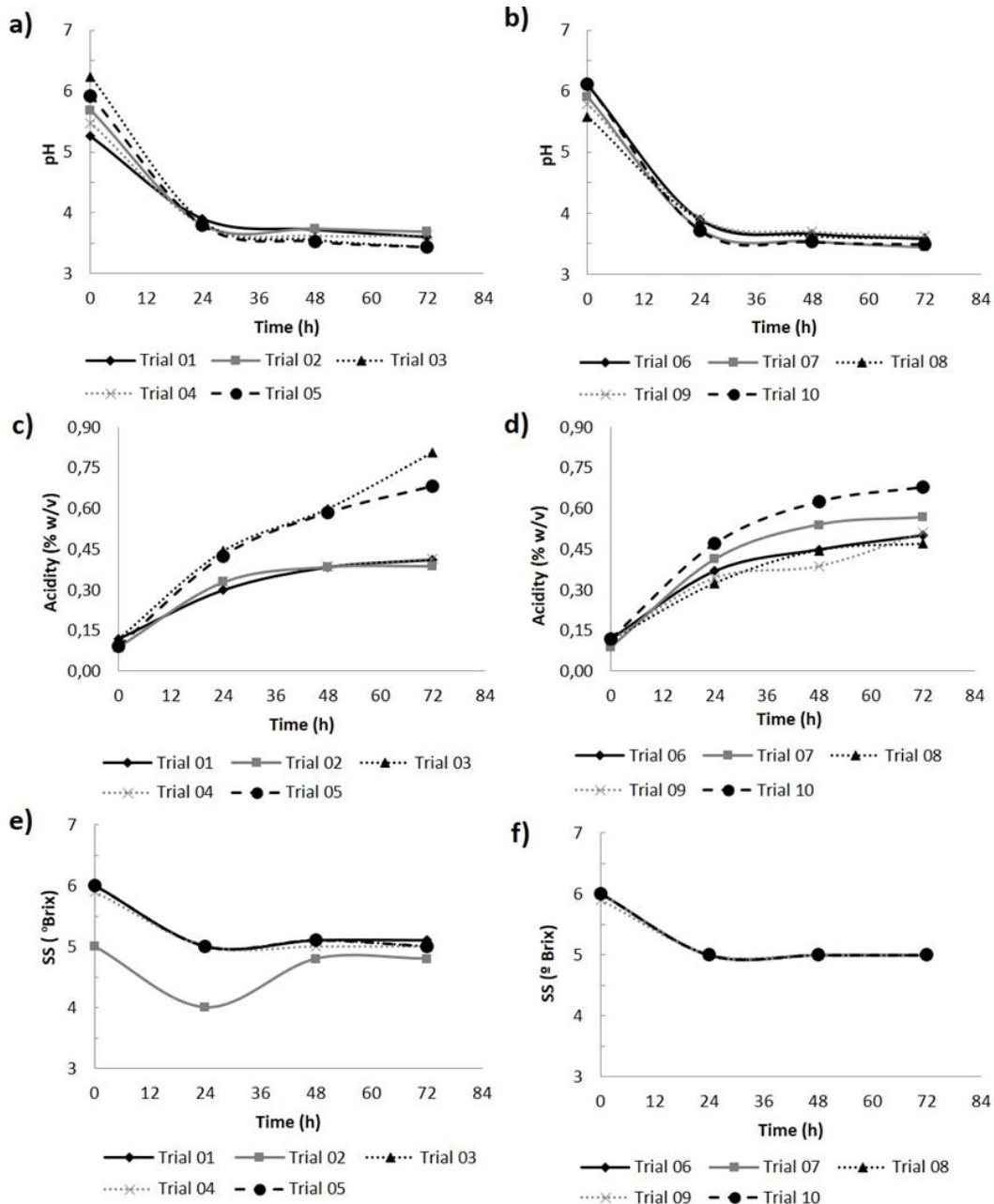


Figure 1 - Kinetic of fermentation for ten trials (formulations can be obtained at Table 1) of lactic fermented beverage using mango pulp, whey and whole milk during fermentation time for: a) and b) pH, c) and d) acidity (% w/v), e) and f) soluble solids (SS °Brix)

The evaluation of the initial conditions is essential for formulation of beverages since the natural acidity of fruits may interfere in LAB’s growth and survival (Fonteles et al., 2013; Di Cagno et al., 2011). For the initial pH values ($t = 0$ h) it was possible to observe a statistical significant difference between values and it was possible to adjusted a codified model ($R^2 = 0.94$; $p < 0.01$) presented in Equation 1, which permitted to obtain its correspondent contour curve (Fig. 2.a). The results showed, as expected, that the increase in milk volume led to an increase in pH values, whereas the higher mango pulp proportion led to

lower pH values. Despite the initial pH differences, after 24 h, all the formulations presented similar pH values (Fig. 1.a and 1.b) with an average at 24 h of 3.84 ± 0.07 and it was not possible to identify a statistical significant difference ($p > 0.05$) between the formulations. Similar result was observed in previous studies also with mango pulp as substrate: pH 3.5 after 24 h (Maldonado et al., 2017) and pH = 3.2 after 72 h (Reddy et al., 2015).

$$pH(t = 0 h) = (5.33) \cdot (Mango) + (5.74) \cdot (Whey) + (6.38) \cdot (Milk) \quad 1$$

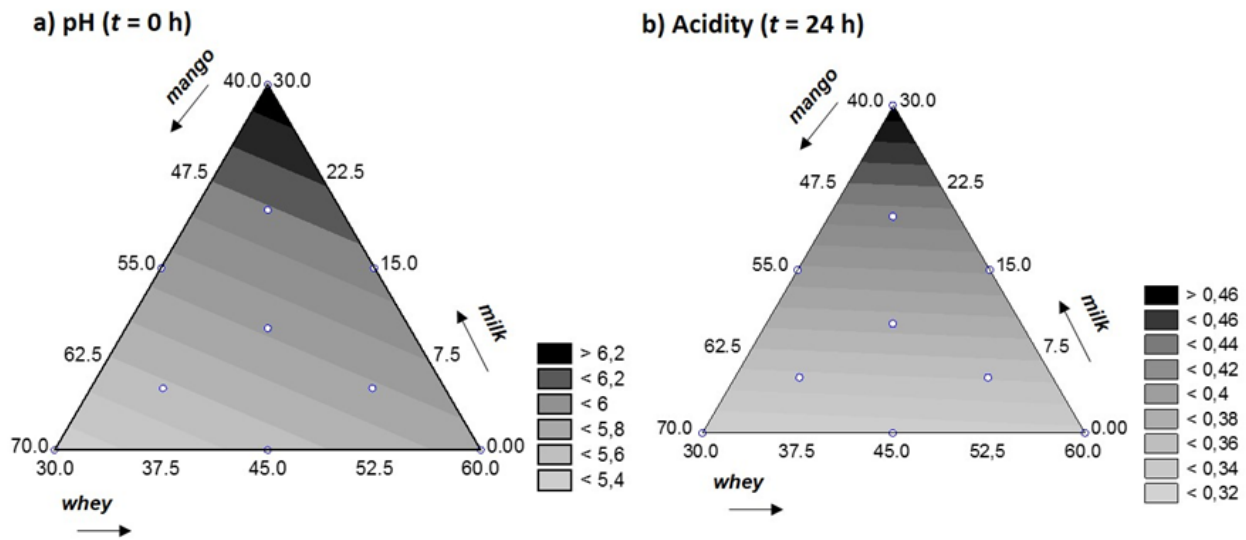


Figure 2 - Contour curves for a) the initial pH ($t = 0$ h) and b) the final acidity ($t = 24$ h) of lactic fermented beverages developed with different proportions (% w/w) of mango pulp, whey and whole milk.

In comparison to pH, the titratable acidity presented an opposite behaviour since there was no statistically significant difference ($p > 0.05$) between formulations at $t = 0$ (as it can be observed at Figures 1.c and 1.d), however, there was a statistically significant difference ($p < 0.05$) after 24 h. The acidity values varied from an average value of 0.11 ± 0.01 % (w/w) (at $t = 0$ h) to values between 0.30 to 0.47 % (w/w) (after 24 h), due to the metabolism of LAB in different formulations. The acidity data (24 h) was adjusted to a coded model ($R^2 = 0.75$; $p < 0.05$) presented in Equation 02 and the obtained contour curve can be observed in Figure 2.b. From the results (Fig. 2.b) it was possible to observe that, similarly for what was observed for the higher pH values (Fig. 2.a), the formulations with higher mango and lower milk proportions resulted in higher titratable acidities, for example, formulations (trials) 10 and 3 (compositions at Tab. 1) resulted in the highest acidities [0.47 and 0.44 % (w/w), respectively]. LAB can ferment different substrates, but milk is their natural habitat and fermentation tend to be faster which could explain higher titratable acidities. In a previous work from the research group (Maldonado et al., 2017), it was obtained a 0.5 % (v/v) of titratable acidity for LAB fermentation (24 h) with only mango as a substrate and a smaller value (0.3 % v/v) with equal proportions of mango and whey.

$$\text{Acidity } (t = 24 \text{ h}) = (0.32) \cdot (\text{Mango}) + (0.33) \cdot (\text{Whey}) + (0.48) \cdot (\text{Milk}) \quad 2$$

Considering the soluble solids content (SS,

$^{\circ}$ Brix) it was not possible to confirm a statistical significant difference ($p > 0.05$) between all formulations, since they resulted in similar SS values at both: $t = 0$ h (5.8 ± 0.3 $^{\circ}$ Brix) and $t = 24$ h (4.9 ± 0.3 $^{\circ}$ Brix), as it can be observed at Figures 1.e and 1.f. Reddy et al. (2015) also observed a reduction in SS with a probiotic mango lactic fermented beverages from 12.0 to 5.8 $^{\circ}$ Brix, after 72 h of fermentation.

The cell counting of beverages obtained with 24 h of fermentation is presented in Table 1 for each formulation, the results showed a steady growth of LAB (reaching over 10^8 CFU/mL) in all formulations (considering the inoculum of $1.0 \cdot 10^6$ CFU/mL). According to the Brazilian legislation, the minimum value for LAB cell counting in lactic fermented beverages is established as 10^6 CFU/mL (Brazil, 2001), therefore, all formulations are in agreement to this specification and can be classified as lactic fermented beverages. It is worth noting that there was an expressive growth of LAB with formulations (trials) 4, 6, 8 and 9 whose proportions varied from: 40 to 60 % (v/v) for mango, 35 – 50 % (v/v) for whey and 0 – 15 % (v/v) of milk (Tab. 1). The influence of mango in LAB growth was also verified in a previous study that evaluated lactic fermented beverage with whey, in which the addition of mango in the formulations increased the cellular counting of *L. casei* cells in 1 log UFC after 24 h compared with formulations without mango (Desnilasari and Kumalasari, 2017). Other similar counting for mango based lactic fermented beverages has been reported such as 10^7 - 10^8 CFU/mL (Maldonado et al., 2017) and 9.81 log UFC/mL (Liao et al., 2016).

Initial sensory analysis

Since fermentation was considered stable for the first 24 h, as discussed before, the ten beverages obtained with 24 h were submitted to sensory evaluation, firstly, with a reduced group of 15 untrained assessors; the average scores obtained (Tab. 1) were statistically analysed. Three of the six attributes evaluated were adjusted to statistically significant models: ($R^2 = 0.61$ and $p = 0.04$), color ($R^2 = 0.76$ and $p = 0.01$), and global acceptance ($R^2 = 0.76$ $p = 0.01$) and their contour curves are presented in Figure 3. From the analysis of the contour curves it was observed the increase in mango proportion resulted in an increase in the assessors' marks to taste (Fig. 3.a), color (Fig. 3.b), and global acceptance (Fig. 3.c) and, an increase in milk proportion, resulted in an opposite (and undesirable) effect. This is a significant result as it demonstrates mango's potential as a substrate for the production of a lactic fermented beverage with high sensory acceptance and low lactose content.

Aroma was the attribute that presented the lowest acceptance, varying between 2.9 and 3.8 (58 to 76 % acceptability index) (Tab. 1). And considering the attributes sweetness and acidity, the average scores were around 3 (the center of the scale): 2.8 ± 0.3 and 3.0 ± 0.2 , respectively (Tab. 1), therefore, these attributes were considered adequate. This is also an indication that the addition of sucrose in order to improve the taste was also favourable and it has been confirmed in other studies with satisfactory sensory acceptance results (Maldonado et al., 2017; Nogueira et al., 2016).

According to Table 1, formulations 1 and 4 presented the best results, especially for global acceptance (score > 4.0 , representing more than 80 % of the acceptability index), and these two formulations are precisely the ones that do not contain milk. Additionally, since the increase in mango proportion improved the sensory acceptance, a formulation with only mango pulp was chosen with formulations 1 and 4 for the final validation and sensory analysis.

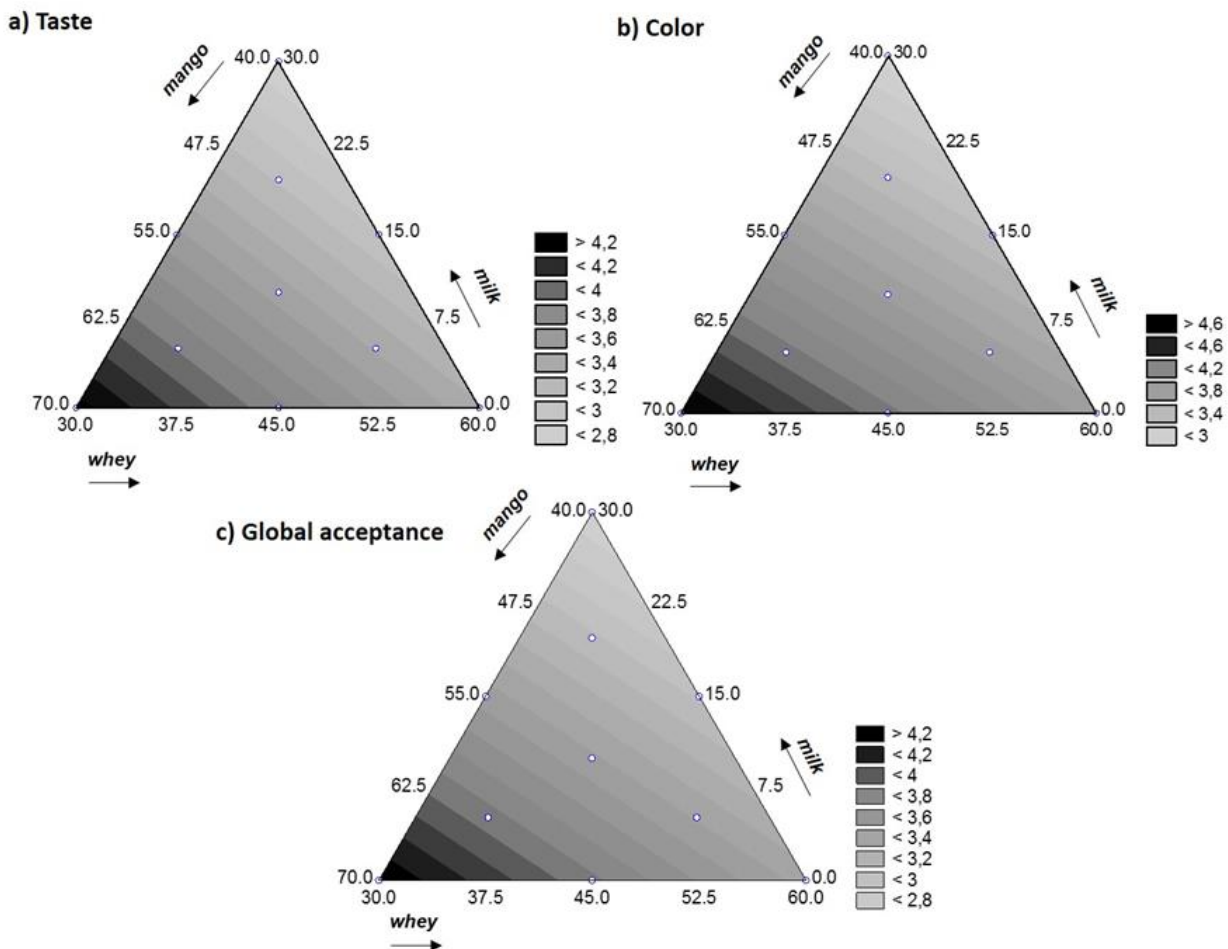


Figure 3 - Contour curves for the sensory analysis of lactic fermented (24 h) beverages developed with different proportions (% w/w) of mango pulp, whey and whole milk for the attributes: a) taste, b) color and c) global acceptance

Validation

The results for pH and SS for the three selected formulations are shown in Table 2. The analysis shows that initially ($t = 0$ h), the lowest pH was obtained with only mango pulpas a substrate but at $t = 24$ h, the lowest proportion of mango resulted in the lowest pH. Regarding the SS values, the formulation with 70 % (w/w) of mango was statistically different from the other two formulations, this tendency remained unaltered with the fermentation as observed before with the mixture design. The coefficients of variation (CV) obtained were lower than 10 % (Table 2) which indicate that there was a good reproducibility among the five replicates realized.

Sensory analysis of the final formulations

The results of the sensory analysis for the three selected formulations are presented in Table 3. The results demonstrated no statistical significant difference ($p > 0.05$) between the three formulations for none of the attributes evaluated. Furthermore, a high global acceptance (from 82 to 88 %) for the three formulations was verified, this result confirms that, among all the formulations evaluated, the three formulations selected were those with the consumer's highest acceptance potential. This is a promising result since it was possible to elaborate the lactic fermented beverage utilizing mango and whey, without lactose, with a good sensory acceptance. The sensorial analysis also permitted to observe that whey has also the benefit to be incorporated in formulations without altering significantly the sensory acceptance.

Table 2 - Average values of pH and soluble solids (SS, °Brix) at 0 and 24 h of lactic fermentation of mango pulp and whey formulations (n = 5 replicates)

Formulations mango:whey % (w/w)	pH		SS (°Brix)	
	0 h	24 h	0h	24 h
HSD ($\alpha = 0.05$)	0.33	0.13	0.96	0.74
70:30	5.13 ± 0.06 ^a (CV = 1.20 %)	3.98 ± 0.03 ^a (CV = 0.84 %)	4.80 ± 0.45 ^a (CV = 9.32 %)	5.00 ± 0.35 ^a (CV = 9.32 %)
55:45	5.00 ± 0.25 ^b (CV = 4.93 %)	3.89 ± 0.03 ^a (CV = 0.88 %)	5.94 ± 0.62 ^b (CV = 10.49 %)	5.98 ± 0.25 ^b (CV = 0.75 %)
100:0	4.47 ± 0.13 ^c (CV = 2.86 %)	4.27 ± 0.09 ^b (CV = 2.19 %)	6.40 ± 0.55 ^b (CV = 8.56 %)	6.50 ± 0.50 ^b (CV = 7.69 %)

HSD = Honestly significant difference. CV = Coefficient of variation. Values in the same column, marked with different superscript letters are statistically different ($p < 0.05$)

Table 3 - Average scores for the sensory evaluation of some attributes (n = 58 assessors) of lactic fermented beverages produced with different proportions (% w/w) of mango pulp and whey

Formulations mango:whey % (w/w)	Attributes					
	Taste	Aroma	Color	Overall acceptance	Sweetness	Acidity
70:30	4.3 ± 0.6	4.2 ± 0.8	4.6 ± 0.5	4.3 ± 0.6	3.5 ± 0.7	3.0 ± 0.7
55:45	4.4 ± 0.8	4.2 ± 0.9	4.7 ± 0.6	4.4 ± 0.6	3.2 ± 0.7	3.3 ± 0.7
100:0	4.2 ± 0.8	4.0 ± 0.8	4.5 ± 0.7	4.1 ± 0.8	3.1 ± 0.8	3.2 ± 0.9

As regards the literature, studies on lactic fermented beverages fruit-based are not rare. However, there are still few studies in which fruit pulps are utilized in combination to whey or milk for the fermentation and not just added after fermentation for flavouring. Castro et al. (2013) evaluated the substitution of milk for whey in a strawberry flavored lactic fermented beverage and obtained the highest global acceptance (77.8 %), utilizing 35 % (w/w) of whey. Santos et al. (2008) evaluated the substitution of milk for whey in a lactic fermented beverage of mango (12 % w/w) and obtained a global acceptance of 86.6 %

utilizing 40 % of whey. Desnilasari and Kumalasari (2017) also verified an increase in color and texture of a whey and mango pulp lactic fermented beverage, however, the addition of mango did not increase the global acceptance of the beverages. Maldonado et al. (2017) obtained lower sensory acceptance of 68.8 % for taste, 74.4 % for aroma and 91.1 % for color also fermenting mango pulp, however, without the sugar addition before the sensory analysis.

The comparison with the literature indicates that the results obtained with the lactic fermented beverages of mango and mango with whey, in this

study, are superior to those related previously. Therefore, under the conditions evaluated in this study, the selected formulations are promising for producing a commercial fruit-based lactic fermented beverage.

CONCLUSIONS

Fermented beverages (and other food products) with lower milk content or milk-free are nowadays a constant requirement from consumers, for different reasons. Fruit pulps are a potential candidates to replace milk in fermented lactic beverages and whey represents a low cost ingredient which can contribute to enrich formulations. The investigation for new substrates and fermentation conditions are important and must be stimulated in order to value local fruits, for example. From this present work, the investigation of the best compositions between mango pulp, whey and milk permitted to suggest three formulations – all milk free – as a substrate for *L. acidophilus* La-5 fermentation and to obtain fermented beverages with a good sensory acceptance. The use of fruit pulps, such as mango pulp (with or without whey) can result in different fermentation profiles than those obtained when milk is (traditionally) used. However, by using fruits and whey it is possible to develop new products with unique characteristics.

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