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Physico-chemical and microbiological characterization of pineapple pulp and concentrate on industrial and laboratory scale

Caracterização físico-química e microbiológica de polpa de abacaxi e do concentrado em escala industrial e laboratórial

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Sarah Caroline Ferreira das Chagas Costa
Especialista em Microbiologia Geral
Instituição: Escola Superior Batista do Amazonas- ESBAM
Endereço: 69057-510, Manaus, AM, Brasil.
E-mail: sarah23caroline@gmail.com

Wallison de Sousa Alves
Graduando em Agronomia
. Instituição: Universidade Federal do Amazonas, UFAM, Brasil.
Endereço: 69080-900, Manaus, AM, Brasil.
E-mail:
E-mail: wallisonsalves@hotmail.com

Rafael de Lima Erazo
Doutorando em Ciências do Ambiente e Sustentabilidade na Amazônia – CCA
Instituição: Universidade Federal do Amazonas – UFAM, Brasil
Endereço: 69080-900, Manaus, AM, Brasil.
E-mail: ra-fa-erazo@hotmail.com

Romero Moreira de Oliveira
Doutor em Engenharia de Recursos Naturais da Amazônia - PRODERNA
Instituição: Universidade Federal do Pará - UFPA
Endereço: 66075-110, Belém, PA, Brasil.
E-mail: romeroengquimico@gmail.com

Wenderson Gomes dos Santos
Doutor em Engenharia de Recursos Naturais da Amazônia - PRODERNA
Instituição: Universidade Federal do Amazonas - UFAM
Endereço: 69077-000, Manaus, PA, Brasil.
E-mail: wenderson@ufam.edu.br

ABSTRACT

In the present work, the physicochemical characterization (total soluble solids (TSS), hydrogenation potential (pH), total titratable acidity (ATT), ratio (RATIO) Brix / titratable total acidity, ascorbic acid and moisture) (Coliformes at 35 ° C and 45 ° C, Molds and Yeasts, Staphylococcus coagulase positive and Salmonella sp.) in frozen pulps and pineapple liquid concentrates, in order to verify if such parameters are in compliance with Normative Instruction No. 01 of the National Agency of Sanitary Surveillance (ANVISA) and Portaria No. 94 Ministry of Agriculture, Livestock and Supply (MAPA). These parameters were studied on both industrial scale and laboratory scale to investigate possible interference in large scale production. It was verified that the physicochemical properties of both the pulp and the concentrate were in accordance with the current legislation, regardless of the scale studied. However, these properties did not show uniformity when the scale of study was modified. Microbiological testing of pineapple samples was in accordance with the limits laid down by legislation and was considered satisfactory from the point of view of overall product quality.

Keywords: Ananascomosus, Fruit Processing, National Sanitary Surveillance Agency, Ministry of Agriculture.

RESUMO

No presente trabalho, a caracterização físico-química (sólidos solúveis totais (TSS), potencial de hidrogenação (pH), acidez titulável total (ATT), razão (RATIO) Brix / acidez total titulável, ácido ascórbico e umidade) (Coliformes a 35 ° C e 45 ° C, Moldes e Leveduras, Staphylococcus coagulase positivo e Salmonella sp.) em polpas congeladas e concentrados líquidos de abacaxi, para verificar se esses parâmetros estão em conformidade com a Instrução Normativa nº 01 da Agência Nacional de Vigilância Sanitária (ANVISA) e Portaria No. 94 Ministério da Agricultura, Pecuária e Abastecimento (MAPA). Esses parâmetros foram estudados em escala industrial e em laboratório para investigar possíveis interferências na produção em larga escala. Verificou-se que as propriedades físico-químicas da polpa e do concentrado estavam em conformidade com a legislação vigente, independentemente da escala estudada. No entanto, essas propriedades não mostraram uniformidade quando a escala de estudo foi modificada. Os testes microbiológicos das amostras de abacaxi estavam de acordo com os limites estabelecidos pela legislação e foram considerados satisfatórios do ponto de vista da qualidade geral do produto.

Palavras-chave: Ananascomosus, Processamento de Frutas, Agência Nacional de Vigilância Sanitária, Ministério da Agricultura.

1 INTRODUCTION

The consumption of processed juices has been increasing every day, due to the lack of time of the population to prepare fruit juice in natura, the practicality that these products offer and the substitution to the consumption of carbonated beverages due to its nutritive value and consumption concern of healthier foods (Matsuura, 2002).

The market for frozen fruit pulps has grown and spread and in all states as an important segment of the production chain. In order to obtain a good quality fruit pulp, care must begin in the cultural tract, during the harvest and continue in the transport, storage and processing of the fruit. Processing of frozen fruit pulps in natura follows the following steps: reception, pre-selection, pre-washing and washing, selection, peeling and preparation of the fruit, pulping, finishing or refining, lung tank, packaging, freezing, storage and distribution (Brunini&Durigan& Oliveira 2002, Mororó, 2000).

In general, pulps are sold in flexible packages (polyethylene plastic bags) or tetra pak for ease of handling. The type of packaging used in packaging has influence on shelf life, since vitamin C presents low stability and is subject to degradation by the action of oxygen, light, pH, sugars and free amino acids (Cid et al., 1991).

In Brazil, the quality of marketed fruit pulp is regulated by Resolution RDC No. 12 of January 2, 2001 and by the Technical Regulation for the Establishment of Identity and Quality Standards for Fruit Pulp - Normative Instruction No. 1 of January 7, 2000 that establish bioindicators of hygienic quality.The quality of the pulp is also related to the preservation of the nutrients and their physical-chemical and sensorial characteristics, which must be close to the fresh fruit, in order to meet the requirements of the consumer and the current legislation.Thus, pH, soluble solids, titratable acidity, total natural sugars and total solids are determined in the specific norms of each type of fruit pulp, according to their specific characteristics (Brazil, 2000 and Brazil, 2001).

The objective of this study was to analyze whether the physico-chemical and microbiological identity parameters of pineapple pulp and concentrate are in compliance with current legislation.

2 MATERIALS AND METHODS

2.1 METHODOLOGY

In order to prepare the pulp and pineapple concentrate, fruit selection was carried out, taking into account the standardization in relation to the size and shape of each species and the absence of mechanical damages and apparent and visual contaminations in the fruit epidermis.Fruits were discarded with presence of injuries and / or deterioration.After selection, Hypochlorite solution (50 ppm), previously acidified (pH = 3.0), was carried out for 10 minutes, and rinsed in trays. To obtain the pulp and concentrate, peels and crowns were removed from the fruits, which were later liquefied, refined and subsequently pasteurized. Soon after, one part of the pulp went to the container and another was used to formulate the liquid concentrate, added sugar syrup, ascorbic acid, citric acid.Subsequently, the physicochemical analyzes were carried out to verify if they were in conformity with the legislation of the products.The pulp and the pineapple concentrates were submitted to the freezing process in a chamber of incubator - Type B.O.D - Model: lucadema-161/01 at -18ºC for a period of 24 hours.The laboratory scale procedure was performed in the Laboratory of Applied Thermodynamics, located at the Faculty of Agricultural Sciences (FAS) of the Federal University of Amazonas (UFAM). While the pulps and pineapple concentrates from the industrial process were obtained from a large company in the fruit processing sector of the metropolitan region of Manaus-AM.

2.2 PHYSICOCHEMICAL ANALYSIS

In order to carry out the physicochemical analyzes, both the industrial and laboratory scale samples were thawed to room temperature, and it was not necessary to pass in a blender because its natural thawing at room temperature already allowed adequate homogenization (IAL, 2008).

Soluble solids content (SS) was determined by refractometry using a portable digital refractometer (brand AKSO, model MA-871, Rio Grande do Sul, Brazil) at room temperature, and the results were expressed as ° Brix. The pH measurement was carried out by introducing the portable pH meter electrode (AKSO brand, model AK103, Rio Grande do Sul, Brazil), previously calibrated, directly into the homogeneous sample, and the reading was performed in triplicate.

To determine the ascorbic acid content, 1 mL of the potassium iodide solution(10%) and 1 mL of the starch solution (1%) were used. For the determination of vitamin C of pineapple fruit was used the solution of potassium iodate 0.02 M.The determination in the pulp, concentrate and pineapple soft drink was used the potassium iodide 0.002 M (IAL, 2008).

The determination of the total acidity was performed by volumetry with indicator, using 0.1 M sodium hydroxide solution (NaOH) with 1% phenolphthalein as indicator.

The relationship of ° Brix by the acidity expressed in organic acid was determined according to the Adolfo Lutz Institute (1985).

2.3 MICROBIOLOGICAL ANALYZES

The microbiological analyzes were carried out in the NUTRICON laboratory, located in the city of Manaus-AM, defined according to standards established by Resolution RDC N°. 12 of the National Health Surveillance Agency of the Ministry of Health - ANVISA (BRAZIL, 2001) and followed the procedures described by Feng et al. (2002) for the quantification of total and thermotolerant coliforms at 45 °C (fecal), by the most probable number method (NMP.g^{-1}), and of molds and yeasts, by direct colony count).

2.4 STATISTIC

The results obtained from the physicochemical characterization of pineapple pulp, pineapple concentrate and pineapple soda both in industrial and laboratory scale were submitted to completely randomized design, with 4 replicates for industry and 4 for laboratory, experimental unit was 32.Data were submitted to analysis of variance and the means were compared by the Tukey test, considering a 5% probability. The results were processed using Statistica 7 software.

3 RESULTS AND DISCUSSION

3.1 INDUSTRIAL SCALE

Samples of fresh pineapple, pulp and liquid concentrate were analyzed for physicochemical and microbiological analyzes.

3.2 PHYSICOCHEMICAL ANALYSIS

The physical-chemical analyzes of the pineapple in natura, pulp, concentrate and its refreshment of the samples in industrial scale, are represented in Table 01.

In the physical-chemical analyzes, all the samples of the industry were within the standards established by the Normative Instruction (Brazil, 2000) and Portaria N°. 94, of August 30, 2016 of the Ministry of Agriculture, Livestock and Supply (MAPA), with the exception of of the pineapple pulp sample to the ascorbic acid parameter.

Ascorbic acid is also an index of food quality (Brazil, 2000) and can be influenced by the conditions of cultivation, processing and storage of raw material and final product (Chitarra; Chitarra, 2005).

According to Ordinance N°. 94, of August 30, 2016, the minimum ascorbic acid content is 21.5 g / 100 g, and among the samples studied, the pulp presented a high value in relation to the established standard.However, this product is marketed with nutritional information that is rich in vitamin C (ascorbic acid), so the product is in compliance with the SVS / MS Ordinance N°. 27, since 1998 that establishes that the product must have 30% of the Daily Intake Recommended (IDR) of vitamin C in 100g of the juice.

The value of °Brix indicates the stage of maturation of the pineapple, so the value of °Brix of the pineapple in natura (13,86), showed that the fruit was suitable for the manufacture of the pulp. The minimum value for °Brix in pineapple pulp is 11, and the pulp analyzed (14, 63) showed a value higher than the norm. Dantas et al. (2010) found average values for soluble solids of 13.13 ° Brix for pineapple pulps, a value close to that found in this work.These values can also be explained by the period to which the fruits were harvested, since in the rainy season the solids can be diluted (Bueno et al., 2002).

Lima et al. (2015) stated that the ratio Total Soluble Solids / Titratable Total Acid (TSS / TTA) or "RATIO" indicates the degree of sweetness of a fruit or its product, evidencing the predominant flavor, sweet or acid, or still if there is balance between them. Thus, the higher this ratio, the sweeter the fruit (Musser et al., 2004). As shown in table 01, the pulp and fresh fruit had a mean RATIO of 48.60 and pulp 51.38, indicating that both the in natura fruit and the pulp had predominant sweet taste, as they presented "RATIO" Upcoming.

Ordinance N°.94 of August 30, 2016 establishes a minimum value for total soluble solids for the pineapple pulp of (11.50). Samples showed values well above that established.

For citric acid, the values of both the *in natura* fruit and the pineapple pulp are in accordance with the regulatory legislation. However, it was observed that these values are lower (0.28-0.30) than those found by Sarzi and Duringan (2002) (0.64) and also those identified by Reinhardt et al. (2004), (0.48 to 0.71).

The pH value obtained from the pineapple in natura (3.64) is close to the values of 3.80 and 3.75 found by Sarzi and Duringan (2002) and 3.60 observed by Medina et al. (1998), for the pearly pineapple pulp. However, the pulp (4.02) showed a high value in relation to the literature.

Fruit moisture and pineapple pulp varied between 82.56% and 85.87%, similar to those observed by Grizotto et al. (2007), who reported moisture between 82% and 92% in pulps of the same fruit.

Table 01. Results of physico-chemical analyzes of pineapple in natura, pulp, concentrate and its refreshment in industrial scale.

Parameters Evaluated	Pineapple in nature	Pineapple Pulp	Pineapple Concentrate	Pineapple Refreshment
Total soluble solids (%)	13,86 ± 0,02 d	14,63 ± 0,02 c	36,42 ± 0,03 a	20,53 ± 0,02 b
pH	3,64 ± 0,03 b	4,02 ± 0,02 a	3,41 ± 0,02 c	4,10 ± 0,14 a
°Brix	14,44 ± 0,03 d	14,62 ± 0,02 c	36,42 ± 0,02 a	21,22 ± 0,02 b
Acidity (g citric acid / 100 g)	0,30 ± 0,01 b	0,29 ± 0,01 b	0,20 ± 0,01 c	0,42 ± 0,02 a
Relation: Brix / Acidity	48,60 ± 2,14 b	51,38 ± 2,27 b	186,88 ± 5,49 a	51,02 ± 2,87 b
Ascorbic acid	55,35 ± 0,03 a	31,96 ± 0,04 d	45,34 ± 0,01 b	33,67 ± 0,03 c
Moisture (%)	82,56 ± 0,02 b	85,87 ± 0,01 a	66,57 ± 0,01 c	50,61 ± 0,04 d

Source: Authors, 2018.
**The averages followed by the same letter do not differ statistically from each other, followed by standard deviation. The Tukey test was applied at a 5% probability level.

The results of the physico-chemical analyzes for liquid concentrate and pineapple soda can also be visualized in table 01, where it can be observed that the parameters were in accordance with

Administrative Rule N°. 544, of November of the MAPA that regulates the identity and the minimum quality characteristics of soft drink, or fruit drink, or vegetable.

The values obtained for vitamin C of the pineapple samples studied, expressed as g / ascorbic acid / 100 g for liquid concentrate and soda, were 45.34 and 33.67, respectively. This decrease in ascorbic acid may have occurred due to the dilution made for the soft drink formulation using liquid pineapple concentrate.

In relation to titratable acidity, the soft drink should have a minimum of 0.20 g / ml in its formulation. It has been found that both the concentrate and the soft drink conform to the established standard. Sá et al. (2003) found high values of citric acid in the whole pineapple juice (0.8 g / 100 mL).

The total soluble solids ratio (ºBrix) / titratable total acidity varied from concentrate to soft drink, from 186.88 to 51.02. According to Pinto et al., (2003), the TSS / TTA ratio is one of the best ways of flavor evaluation, being more representative than the isolated measurement of sugars and acidity.

For pH, the samples presented approximate values, the concentrate (3.41) and soda (4.10). In their studies with pineapple juice Sá et al. (2003) found values close to pH (3,6). In another study, (Matsuura and Rolim, 2002) found higher mean values in pasteurized whole pineapple juice for pH (3.84).

The ºBrix degree of the concentrate (36,42) and the soft drink (21,22), this discrepancy occurs due to the dilution that occurs to prepare the soft drink. The pineapple soda sample is in accordance with the requirements of the Codex Alimentarius, which establishes minimum limits for soluble solids content in fruit juices for reconstitution. In the case of pineapple juice a minimum soluble solids content of 10 ° Brix is required. Para Sancho et al.(2007),the solubles contained are the total of all solids dissolved in water, starting with sugar, salts, proteins, acids.

The humidity of the samples presented divergence in the obtained results, the concentrate (66,57) and soft drink (50,61). This difference occurs by the composition of the liquid concentrate, as it carries sugar syrup in its preparation, while the soft drink is prepared from the dilution of the concentrate.

3.3 MICROBIOLOGICAL ANALYZES

The results of the microbiological analyzes for the detection of salmonella and total and fecal coliforms in the industrial pulp and liquid concentrate of pineapples (Table 02), showed that these were in accordance with the current legislation, which establishes absence of Salmonella in 25g and one maximum limit of $5x10^2$ coliforms at 45º / g of the samples according to Resolution-RDC Nº. 12 of January 2, 2001 of the National Agency of Sanitary Surveillance (ANVISA), since no such agents

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were found in the samples. The presence of bacteria in frozen foods is a fact. In a study published in 2012 by Santos et al., the presence of fecal coliforms in 100% of pulps of several frozen fruits analyzed was observed.

For Parissenti et al. (2013), contamination by total and endogenous or fecal coliforms in frozen pulps has been documented in the literature, probably associated with inadequate handling or contamination of equipment. The group of total coliforms includes bacteria in the form of gram negative rods, aerobic or anaerobic, does not spore and ferments lactose, producing acid and gas at 35 ° / 37 ° C. Thermotolerant or fecal bacteria are those that originate from the intestinal tract of humans and other warm-blooded animals, ferment lactose with gas production in 24 hours, and withstand temperatures above 40 °C. This group includes three genera: Escherichia, Enterobacter and Klebsiella.

Regarding mold and yeast counts, Normative Instruction No. 01 of January 7, 2000the Ministry of Agriculture, Livestock and Food Supply (MAPA) establishes the maximum limit of 5 x 10^3 CFU g^{-1} for counting molds and yeasts in fruits in natura.

According to Franco and Landgraf (2005), low counts of molds and yeasts are considered normal (not significant) in fresh and frozen foods. However, high counts represent, in addition to the deteriorating aspect, that may even lead to the rejection of the product, a risk to public health due to the possible production of mycotoxins by some species of mold. Contamination of fungal frozen fruit pulps appears to be frequent.Pereira et al. (2009) observed counts higher than $5x10^3$ CFU g^{-1} of filamentous fungi and yeasts in 13.33% of the samples, indicating the contamination. Santos, Coelho, and Carreiro (2008) found 29.6% of the samples with values above that allowed for molds and yeasts. Thus, an alternative to achieving satisfactory microbiological quality is the use of heat treatments, such as bleaching and pasteurization. Irregularities in the agribusiness layout and unsafe conditions on facilities, equipment, furniture and utensils, production and transportation, and food handlers were found in the agribusiness in which the analyzed samples were obtained.

The number of outbreaks of foodborne diseases (DTAs) is increasing every year and most consumers are unaware of the requirements for proper food handling. In the microbiological analyzes, no industrial sample showed *Staphylococcus sp*. In studies conducted by Geus*et al*. (2006), we can have an idea of how important the data obtained through searches for DTAs are; the bacteria that are often associated with outbreaks are *Staphylococcus aureus and Salmonella sp*.

Table 02. Results of the microbiological analyzes of the pulp and pineapple liquid concentrate on an industrial scale.

Microbiological analysis	Pineapple Pulp	Liquid concentrate	Normative Instruction N°01/00 and RDC N° 12/01 VMP
Coliformsat 35 °C	<0,9 NMP/g	<0,3 NMP/g	-
Coliforms at 45°C	<0,9 NMP/g	<0,3 NMP/g	$5x10^3$
Molds and yeasts	<10 UFC/g	$1,8 x 10^2$ UFC/g	-
***Staphylococcus*positive coagulase**	<10 UFC/g	<0,3 NMP/g	-
***Salmonella* sp.**	Absence	Absence	Absence in 25g

Source: Normative Instruction N°01/00 and RDC N° 12/01.
* - means without parameters in Brazilian legislation.

3.4 LABORATORY SCALE

Samples of fresh pineapple, pulp, concentrate and liquid soda were analyzed for physicochemical and microbiological analyzes and compared with industrial scale samples using the same parameters.

3.5 PHYSICAL-CHEMICAL ANALYSIS

The physical chemical analyzes of in natura pineapple and pulp in laboratory scale are represented in Table 03.

Analyzing this table,it is verified that the physicochemical parameters (soluble solids, °Brix, acidity and ascorbic acid) are in conformity with the abovementioned norm.

The total soluble solids of both pineapple fruit (15,03) and pulp (16,31) in laboratory scale were higher than those found in industrial scale 13,86 and 14,63, respectively, showing that the change of scale provides a physicochemical properties. This can be explained by the greater complexity of the macroscopic phenomena (movement, mass and energy) that involve the process on an industrial scale.

Regarding degree ° Brix, laboratory pulp (16.44) showed a high value in comparison to the industrial one (14,62), this can be explained due to ° Brix found in the pineapple in natura used in scale of bench (16.02) is higher than the larger scale (14.44).

For the moisture in the laboratory scale, the pulp (81.51%) showed a lower value than in the industrial scale (85.87%), and for the pineapple in natura also the same occurred, in the small scale process a value was found of 80.56% and in industrial area of 82.56%.

This tendency of the values of the bench scale properties to be greater thanindustrial, was repeated in the following physico-chemical properties of both the fresh fruit and the pineapple pulp: acidity (citric acid) and vitamin C (ascorbic acid).

While the properties of pH and Brix / Acidity (RATIO) presented an inverse behavior of the other properties. The fruit used in the workbench showed higher titratable acidity in comparison to the one used in the company, so the RATIO of the pulp produced in the laboratory was affected, because this is a relation between the ° Brix of the fruit and its acidity.

Table 03. Results of physical-chemical analysis of pineapple in natura, pulp, concentrate and its refreshment in laboratory scale.

Parâmetros Avaliados	Pineapple in nature	Pineapple Pulp	Pineapple Concentrate	Pineapple Refreshment
Total soluble solids (%)	15,03 ± 0,03 d	16,31 ± 0,01 c	36,06 ± 0,03 a	22,98 ± 0,03 b
pH	2,94 ± 0,03 d	3,41 ± 0,01 c	4,02 ± 0,01 b	4,71 ± 0,01 a
°Brix	16,02 ± 0,02 d	16,44 ± 0,02 c	36,52 ± 0,02 a	23,02 ± 0,02 b
Acidity	0,33 ± 0,01 d	0,43 ± 0,01 b	0,38 ± 0,01 c	0,47 ± 0,02 a
Relation: Brix / Acidity	48,24 ± 1,85 b	38,29 ± 1,63 c	95,53 ± 2,39 a	49,28 ± 1,59 b
Ascorbic acid	60,02 ± 0,02 d	42,24 ± 0,01 b	60,01 ± 0,01 c	49,37 ± 0,02 a
Moisture (%)	80,56 ± 0,03 c	81,51 ± 0,01 b	63,02 ± 0,02 d	82,39 ± 0,01 a

** The averages followed by the same letter do not differ statistically from each other, followed by standard deviation. The Tukey test was applied at the 5% probability level.
Source: Authors

The physico-chemical analyzes of the liquid concentrate and pineapple soda in laboratory scale can be verified in table 03, where one can observe the parameters established by Ordinance N ° 544, November 1998 of MAPA and Codex Alimentariux that regulate these products.

The values of ° Brix of the liquid concentrate of laboratory pineapple (36,52) showed proximity with the industrial one (36,42), but in relation to the refreshment the ° Brix (23,02) of bench was greater in relation to the industrial process (21,22).

In relation to the total soluble solids, the same previous correlation was observed.

Ascorbic acid and citric acid presented higher bench scale measurements for both soft drink and liquid concentrate. This difference in the amounts of these organic compounds may be related to the different state of maturation of the pineapple used for industrial scale production, factors such as soil type and harvest time are also capable of influencing these compounds.

The Brix / Acid ratio as mentioned in another situation is calculated according to the Brix content in relation to the acidity, so the concentrate and pineapple soda in the industrial process (186,88 – 51,02) presented higher values in comparison to small-scale production (60,01 – 49,37).

For the pH, the concentrate and refreshment reproduced in the laboratory (4,02– 4,71) presented greater results than those of the productive process of the company (3,41 – 4,10).

The moisture content in relation to the liquid concentrate presented approximate values in both laboratorial (63,02%) and industrial (66,57%), while for soft drink it was observed that in laboratorial scale (82,39%) the moisture showed value higher than industrial (50,61%).

3.6 MICROBIOLOGICAL ANALYZES

No sample of pineapple pulp and concentrate produced at the bench scale (Table 04), presented coliforms at 45ºC and 35ºC, being within the quality standards required by the National Health Surveillance Agency (2001).From the comparison of the results obtained in this small scale test with the results obtained in relation to the industrial process, it can be verified that the levels of coliform contamination at 45ºC in the pineapple pulps are non-existent. The presence or absence of a few microorganisms in fruit juices and / or pulps can be explained by the presence of natural antimicrobial substances such as essential oils, phenolic compounds, benzoic acid, sorbic acid and other organic acids of short chain (GELDREICH et al., 1962).

According to the results presented in this research, the samples of pulps and liquid pineapple concentrates analyzed were within the quality standard required in RDC N° 12 of January 2, 2001 (NATIONAL SANITARY SURVEILLANCE AGENCY, 2001). They were within the standard for coliforms at 45 °C and absence of Salmonella. With regard to molds and yeasts, RDC legislation n° 12 of January 2, 2001, has no standard. In normative instruction nº 1 of January 7, 2000, the General Technical Regulation was approved for setting the Identity and Quality Standards for fruit pulps, including the counting of yeasts and molds for this class of products, setting maximum limits for pulp in natura (5,0 x 10^3 / g). (BRAZIL, 2000). High counts of these microorganisms may indicate pulp deterioration and represent a health risk, considering that some mold species produce mycotoxins (GRECO et al., 2012).

However, the analysis of liquid pineapple pulps and concentrates is necessary, since other microorganisms can grow, even in the presence of these antimicrobial compounds.

For *Staphylococcus*, the concentrate and the pineapple pulp were absent on laboratory scale, while on a large scale it presented a small amount of this microorganism.

Table 04. Results of the microbiological analyzes of the pulp and liquid concentrate of pineapple in laboratory scale.

Microbiological analysis	Pineapple Pulp	Liquid concentrate	Normative Instruction N°01/00 and RDC N° 12/01 VMP
Coliforms at 35 °C	Absence	Absence	-
Coliforms at 45 °C	Absence	Absence	$5x10^3$
Molds and yeasts	< 3 UFC/g	1 x 10^2 UFC/g	-
***Staphylococcus*positive coagulase**	Absence	Absence	-
***Salmonella* sp.**	Absence	Absence	Absence in 25g

Source: Normative Instruction N°01/00 and RDC N° 12/01.
* - means without parameters in Brazilian legislation.

4 CONCLUSIONS

1. The physicochemical properties of both pulp and concentrate were in accordance with current legislation, regardless of the scale studied. However, these properties did not show uniformity when the scale of study was modified.

2. The microbiological tests of the pineapple samples were in compliance with the limits established by the current legislation and were considered satisfactory from the point of view of the overall quality of the product.

3. From the comparison of the results, in relation to the small-scale microbiological analysis with the results obtained in the industrial process, it can be verified that the levels of contamination by coliforms at 45ºC in the pineapple pulps are non-existent.

4. For Staphylococcus, the concentrate and the pineapple pulp were absent on laboratory scale, while on a large scale it presented a small amount of this microorganism.

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