Monitoring the extraneous matters in pulps of tomato, guava, mango and strawberry marketed during the seasons of the year

Monitoramento de matérias estranhas em polpas de tomate, goiaba, manga e morango adquiridas no comércio durante as estações do ano

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ABSTRACT
Fruit-derived products sold in Brazil and for exportation are required to comply with the quality and safety standards. These products and, among them, the fruit pulps may contain extraneous materials due to the inappropriate conditions or practices during their production, storage and distribution, including filth, decomposed material and miscellaneous materials. This study aimed at evaluating the sanitary conditions (regarding to extraneous materials) of fruit pulps sold in the Great São Paulo, during the four seasons of 2010. This investigation analyzed 115 tomato pulp, 93 guava pulp, 99 strawberry pulp and 89 mango pulp by means of the techniques described in the AOAC, 18th, 2005, Chapter 16 - Extraneous Materials: Isolation. Insect fragments were the most frequent filth category detected in the pulps (in 93 % of guava and strawberry, 77 % of tomato and 48 % of mango samples), followed by the rodent hair (in 24 % of tomato, in 3 % of guava, in 1 % of strawberry and in 0.5 % of mango samples). The occurrence of mites was mostly frequent in strawberry samples (33 %). This study indicated that the majority of the analyzed pulps showed satisfactory sanitary conditions, evidencing that the Good Manufacturing Practices was adopted by the productive sector.
Keywords. fruit pulps, insect fragments, rodent hair, mites.

RESUMO
Os produtos derivados de frutas comercializados no Brasil e os exportados exigem do setor produtivo o atendimento aos padrões de qualidade e segurança. Esses produtos, dentre eles, as polpas de frutas podem conter matérias estranhas em função de condições ou práticas inadequadas de produção, armazenamento ou distribuição, incluindo-se sujidades, material decomposto e materiais diversos. No presente estudo foram avaliadas as condições sanitárias (presença de matérias estranhas) de polpas de frutas comercializadas na Grande São Paulo, durante as quatro estações do ano de 2010. Foram analisadas 115 amostras de polpa de tomate, 93 de polpa de goiaba, 99 de polpa de morango e 89 polpas de manga, empregando-se as técnicas descritas na AOAC, 18 ed, 2005, Capítulo 16 - Matérias Estranhas: Isolamento. Os fragmentos de insetos foram detectados na maior porcentagem de amostras (em 93 % de goiaba e de morango, em 77 % de tomate e 48 % de manga), seguidos de pelos de roedor (24 % em tomate, 3 % em goiaba, 1 % em morango e 0,5 % em manga). Os ácaros foram mais freqüentes nas amostras de morango (33 %). No geral, a maioria das polpas analisadas apresentou condições sanitárias satisfatórias, o que indica que as Boas Práticas de Fabricação foram adotadas pelo setor produtivo.
Palavras chaves. polpas de frutas, fragmentos de insetos, pelos de roedor, ácaros.

INTRODUCTION

Fruits play an important role in human health, due to their nutritional value, and they are well accepted because of their aroma and flavor. Currently, there is an overall incentive to increase consumption of products that improve quality of life, including fruits, since they are sources of vitamins, minerals, carbohydrates and fibers. Fruit production is subject to fluctuations owing to several factors such as climatic conditions. Some fruits are likely to be sensitive to crushing and consequently decomposition thus requiring rapid consumption. Industrialization allows the effective use of harvesting by manufacturing byproducts, including fruit pulp, which is used as a raw material in the preparation of jams, sweet paste, nectars and other products[1].

The diversity of fruit-derived products developed and distributed in the Brazilian market and also exported requires adherence to quality and safety standards by the fruit pulp industry so that its products meet current regulations to satisfy the increasingly demanding consumers.

The Brazilian laws implemented to ensure the quality of these products are: Normative Instruction Nº 01/2000 of the MAPA (Ministry of Agriculture, Livestock and Supply)[2], Resolution RDC Nº 272/2005 ANVISA/MS (National Agency of Sanitary Surveillance/ Ministry of Health)[3], Resolution RDC Nº 14/2014 ANVISA/MS (National Agency of Sanitary Surveilance/ Ministry of Health)[4], Ordinance Nº 326/1997 of the SVS/MS (Secretariat of Health Surveillance/Ministry of Health)[5], and Resolution RDC Nº 218/2005 ANVISA/ MS (National Agency of Sanitary Surveilance/Ministry of Health)[6].

According to the Normative Instruction Nº 01/2000 of the MAPA[2], fruit pulp is the non concentrated, unfermented undiluted product from the edible part of the fruit, obtained from fleshy, healthy and ripe fruit by means of a technological process able to keep the minimum total solids, with physical, chemical and organoleptic characteristics of the fruit. It should not contain dirt, filth, parasites, insect fragments and pieces of non-edible parts of the fruit and plant.

Extraneous materials may be present in the pulps due to inappropriate conditions or practices for production, storage and distribution, including filth, decomposed materials and various materials such as soil, sand, glass and other foreign elements[7].

Filth is defined as any foreign element to the product resulting from livestock contamination (rodents, insects or birds) or any other objectionable matter due to inadequate handling, processing and distribution[7].

Among the extraneous materials of biological origin, adult insects and their intermediate stages such as eggs, larvae and pupae are found more frequently[8]. Other extraneous materials of biological origin that can be found in food are mammal hair. Its detection may indicate product contact with animals or their excrement and / or urine. Among mammals, some have a habit of licking themselves, at which time they swallow their own hair and as it is not digested by their digestive system, it is later eliminated in their feces[9].

Birds can also contaminate foods, being considered vectors, hosts or carriers of various pathogens. Parasites, mites and lice may be present in the feather barbules that come off and may fall into the product. In addition, if *Salmonella* is present in the digestive tract of the bird, it may contaminate the food through its excrements[10-12].

The aim of this study was to evaluate the health conditions of the fruit pulp sold in Greater São Paulo area, during the four seasons, analyzing and identifying the extraneous materials recovered from it.

This study provides occurrence of extraneous materials such as: whole insects, insect fragments, mites and rodent hair in the pulp of guava, tomato, strawberry and mango, in the pulps marketed in the Greater São Paulo area as well as subsidies so that tolerance limits can be set for these materials in the regulatory laws.

This study contributes to data that provide subsidies to assessments of fruit pulp especially because it samples were collected during the seasons, allowing not only evaluate the contamination by extraneous materials and also draw a profile of the quality of the pulps fruit.

MATERIAL AND METHODS

Material

A total of 115 samples of tomato pulp, 93 of guava pulp, 99 of strawberry pulp and 89 of mango pulp, purchased from retail stores in the Greater São Paulo area during the spring, summer, autumn and winter of 2010 were analyzed.

Were analyzed 114 samples acquired in summer season (25 of mango, 29 of strawberry, 32 of tomato and 28 of guava pulp), 66 samples acquired in spring season

Table 1. Percentage of samples containing extraneous materials found while monitoring guava pulp, tomato, strawberry and mango

Pulps	Seasons	IF (%)	RH (%)	Mites (%)
Guava	Summer	93	7	7
	Autumn	90	0	14
	Winter	77	5	9
	Spring	76	0	14
	Mean	**84**	**3**	**11**
Tomato	Summer	77	35	7
	Autumn	60	25	0
	Winter	55	14	4
	Spring	50	23	9
	Mean	**61**	**24**	**5**
Strawberry	Summer	93	0	62
	Autumn	87	0	46
	Winter	72	0	11
	Spring	61	4	11
	Mean	**78**	**1**	33
Mango	Summer	48	0	0
	Autumn	38	0	0
	Winter	45	1	0
	Spring	22	1	0
	Mean	**38**	**0,5**	**0**

IF: insect fragment, RH: rodent hair

(21 of mango, 22 of tomato and 21 of guava pulp), 96 samples acquired in fall season (21 of mango, 24 of strawberry, 29 of tomato and 22 of guava pulp) and 89 samples acquired during winter season (20 of mango, 18 of strawberry, 29 of tomato and 22 of guava pulp). Those samples were frozen and presented with individual package ready for consumption.

The glassware and consumables used to perform the techniques are described by the Association of Official Analytical Chemistry (AOAC) Official Methods of Analysis of AOAC International, 18th edition, 2005, chapter 16, Extraneous Materials: Isolation[7,8].

Insect fragments and rodent hair standards produced at our own laboratory using the techniques described by Brickey et al[13], with modifications, were used for the control and verification of the analytical methods. Fragments of cockroaches (Order Blattodea) were used instead of the *Tribollium sp* described by the technique mentioned, and fragments of the *Mus musculus,* obtained from the Animal Facility of the Adolfo Lutz Institute of São Paulo.

Methods

The methods used, according to AOAC 2005, technique 16:10:05 - method 964.23 (a) for guava, mango and tomato pulps, and technique 16:10:06 - method 950.89 (a) for strawberry pulp were validated at the Laboratory of Morphology and Food Microscopy Adolfo Lutz Institute of São Paulo. Some adjustments have been made to the analytical methods as they had a better performance to recover the extraneous materials[14].

During the analytical process, insect fragment and rodent hair patterns produced at our own laboratory using the techniques described by Brickey et al[13] with modifications were used.

To perform the analysis, blank samples were used as an internal control to check for possible contamination of glassware, sieves and other consumables because insect fragments and rodent hairs may remain adhered to the walls of these samples and result in false-positive samples.

RESULTS AND DISCUSSION

The greater recovery of insect fragments in the samples was in summer: 93 % for guava, 77 % for tomato, 93 % for strawberry and 48 % for mango may have been due to the fact that it is the hottest season of the year. This type of extraneous materials was the most prevalent in the pulps analyzed.

Rodent hair was the second most common extraneous material found in the pulps studied; however, the percentage of samples containing this type of extraneous material was not high. Tomato pulp had the highest average (24 %, considering the seasons) of samples containing rodent hairs among the four pulps studied. In guava this average was 3 %, 1 % in strawberry and 0.5 % in mango).

Whole insects, larvae and mites were found in some samples. Table 1 shows the results obtained for guava, tomato, strawberry and mango pulps.

Guava pulp

Guava pulp had the highest average of samples with insect fragments (84 %) compared to other pulps, and in summer and fall the percentage of positive samples was higher, which may be related to climatic factors, because the rise in temperature results in higher occurrence of insects.

Despite the high percentage of samples containing fragments of insects, this number does not exceed the average of 8 per sample, as shown in Figure 1.

Insects belonging to the Order Hemiptera, which are sucking insects that feed on fruit and nectar, were found in these pulps.

Rodent hairs were found in this pulp, but in a small proportion and number (3% on average).

Mites were found in all seasons, and the highest percentage of positive samples was reported in spring and fall (14 %), but not in large quantities.

The presence of mites in this type of pulp was significant and could be related to the incomplete removal of the fruit peel, since mites are found on their surface.

Despite not having been presented in Table 1, bat hairs were found in 2 samples of guava pulp, and one had a tuft containing over 13 hairs, which may be related to the phytophagous feeding habits of these animals. The occurrence of phytophagous bats is connected with climatic conditions; moreover, these bats are found only in tropical and subtropical regions, such as Brazil[15].

Tomato pulp

The insect fragments found in these pulps may be related to the quality of raw materials, inefficient cleaning and processing failures, indicating that the Good Manufacturing Practices were not adopted (Figure 1).

Tomatoes may be attacked by fruit flies (*Drosophila*) hence their eggs and larvae can be found in the final product. This type of insect is found in fruits and decomposing vegetables, leaving eggs on their surface, and in hot weather they complete their life cycle in 8-10 days[10]. In this study, insects of the genus *Drosophila* were found in some samples, in addition to other whole unidentified insects.

A sample acquired in winter contained three insect larvae, but these were not identified.

Rodent hairs were found in greater numbers in tomato pulp when compared to the other fruit pulps studied as showed in Table 1. The prevalence of rodent hairs may be related to how tomatoes are grown – they are a creeping plant, grown in open fields. Another factor that may contribute to these numbers is the harvesting process and industrial production. Usually tomatoes are cultivated in crop rotation with corn – a known source of foods for rodents, thus assisting in their reproduction and development. At the end of cultivation, these rodents and/or their residues (hairs and excreta) remain in the soil and during the mechanical harvesting, fruits are collected in deeper areas, carrying waste and/or rodents present in the soil. This occurrence could be minimized by the use of manual harvesting, as fruit selection and separation is more thoroughly[16].

Producers claim that when tomatoes are sprayed with pesticides, the hairs that are stuck on their epidermis by static force are covered by a thin film of chemicals, and their removing become harder during the cleaning process, and therefore their presence may be detected in the final product[16].

The identification of rodent hairs is important because they are indicators of accidental or fecal contamination. These animals represent a serious problem in all phases of processing, production and storage of food, being potential transmitters of a number of diseases including leptospirosis, salmonellosis, plague (bubonic, pneumonic, septicemic) and viruses. Their presence in food makes it potentially harmful to health and is a cause for the non-compliance with the current legislation[4].

Strawberry Pulp

Insect fragments were found on average in 78 % of strawberry pulp samples, with the highest percentage of positive samples reported in summer and fall. However, the amount of insect fragments was lower than 10, as shown in Figure 1.

Regarding the samples collected in fall, 87 % of them contained insect fragments, and one sample had 20 insect fragments while another, 16. The sample showing 20 fragments also contained 15 eggs of insects and 7 mites. This sample might have been made with raw material of poor quality. These insect fragments were not identified because they were too small to compare with any identification parameter.

Although aphid insects are considered the worst plague in this type of culture in some parts of Brazil, we did not find them in our study. However, we found other insects such as those belonging to the Order Hemiptera (Coccidia) and also to the Order Thysanoptera (thrips)[17].

The presence of mites in strawberry pulps was significant, ranging from 11 % for the samples collected in winter and spring, up to 62 % for the samples collected in the summer. Despite the lack of identification and classification of the mites found, in 3 samples we found from 2 to 3 of Oribatid mites per sample. This is a species of soil-living mites and their presence is the pulp can be explained by the fact that strawberry is a creeping plant.

Mites are arthropods of the class Arachnida found in various foods, may originate from soil and areas adjacent to the deposits and be carried by insects, birds and rodents. Mites can cause physical damage and carry fungal spores. Some species are considered potential intermediate hosts of parasitic organisms that infect mammals[17].

The mite species that appears most frequently in this type of culture is the spider mite, *Tetranychus urticae*, causing significant damage and losses, and whose control is difficult to be implemented. Mites appear mainly during fruiting and harvest. They adhere to the fruits' surface and may reduce both their quality and quantity[18,19].

One factor that may have contributed to the large amount of mites in this type of pulp may be the fact that phytoseiid predatory mites are used as an alternative for

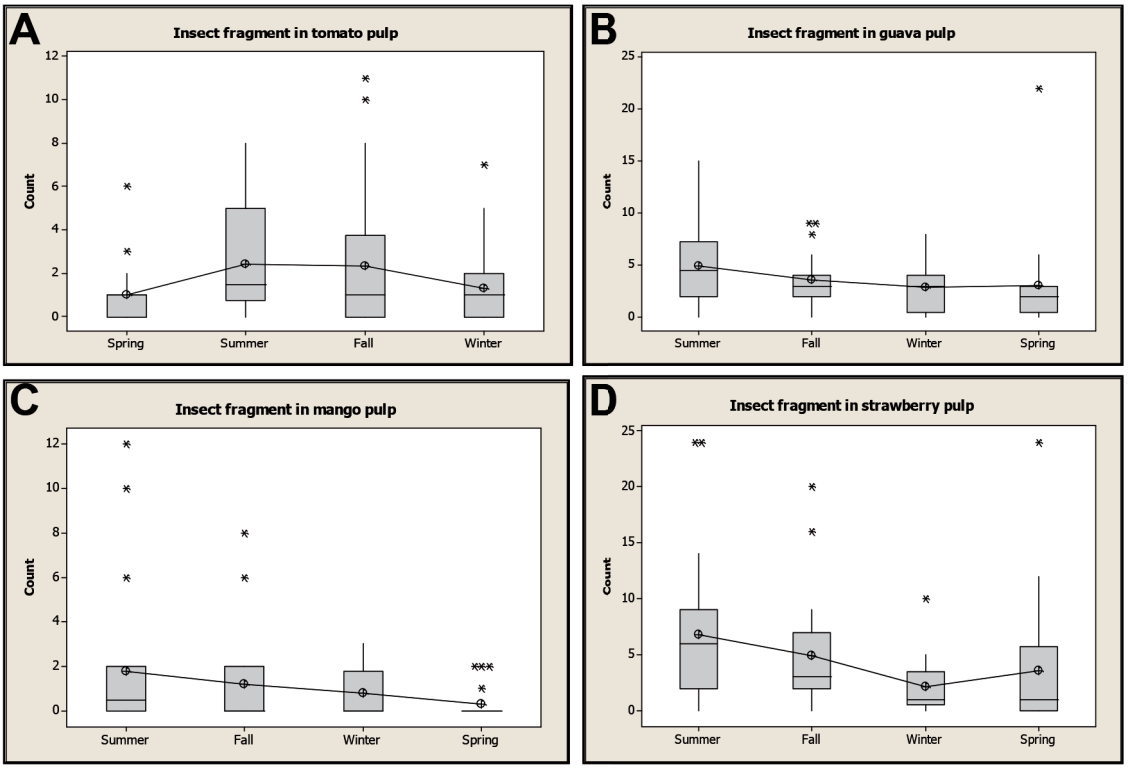

Figure 1. Presence of insect fragments in fruit pulps marketed during the seasons of the year. (A) tomato; (B) guava; (C) mango; (D) strawberry

the biological control of spider mite on strawberry crops, thus resulting in their presence in the final product[18,19].

Regarding the presence of rodent hair, its occurrence was not significant in strawberry pulp samples.

Mango pulp

Mango pulp showed the least amount of extraneous materials in comparison with other pulps. This may be related to the pulp processing since total removal of the skin occurs. Among the extraneous materials found, insects of the Order Hemiptera were the most common occurrence, which may be related to their phytophagous diet. Other extraneous materials were recovered, such as bird barbules, bat hairs, eggs, insect fragments and whole insects of other orders (Figure 1).

CONCLUSION

Our study presents an overview of the sanitary conditions of the pulps sold in São Paulo regarding the occurrence of extraneous materials in different seasons. Overall, these results indicate that the fruit pulp industry has adopted the Good Manufacturing Practices.

Even with the adoption of preventive measures, industries claim that the presence of some extraneous materials is inevitable. An example is the occurrence of the rodent hair in tomato pulp, which might be due to how tomatoes are grown thus making it very difficult to be eliminated during the manufacturing process. We believe the same occurs as to the presence of mites in strawberry pulps.

We observed that the highest percentage of samples containing fragments of insects came from those collected in the summer, which may be related to the high temperatures and the insects' life cycle.

This study provided data that can collaborate with the establishment of tolerances for extraneous materials in this type of product.

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