Original Research Article

Study of the bactericidal effect of cloves, cinnamon, and sodium benzoate on the preservation of Haden mango and melon.

Abstract

An experimental study was conducted to determine inhibition and / or destruction of pathogens in the following; Controls, M-EC, MS, Me-EC, Me-S, Treatments M-EC-LC, LC-MS, LC-EC-I, Me-S-CL, M-EC-C, M-S-C, Me-EC, Me-SC, M-EC-B, M-S-B, Me-EC-B and Me-S-B. Where: M = mango, Me = melon, EC = *Escherichia coli*, S = *Salmonella sp*, CL = clove, C = cinnamon, B = sodium benzoate. Qualifying each treatment according to the bactericidal power, as: non-effective, minimum, and fulminant lethal effect on days 0 (t_0), 7 (t_7) and 15 (t_{15}); the bactericidal effect of aqueous extracts of cinnamon, clove in concentrations of 2.5% and sodium benzoate at concentrations permitted by FDA 0.1% was evaluated using the method of quantification or counting of forming colony units (FCU), on two bacterial strains, *Escherichia coli* and *Salmonella enteritidis*, were inoculated in samples of tropical fruits, mango Haden (*Mangifera indica*) and Cantaloupe melon (*Cucumis melo*).

The bactericidal effect of clove was different in the two fruits treated; in the mango inoculated with *E. coli* was observed a minimal effect and in the other hand, the sample inoculated with *Salmonella spp*. there was no bactericidal effect. In the melon sample inoculated with both bacteria, the bactericidal effect of clove was observed. The effect of cinnamon was minimal in both fruits inoculated with *E. coli*. In the mango inoculated with *Salmonella spp*. there was no bactericidal effect. In the melon, it was a lethal effect.

The use of sodium benzoate had a bactericidal effect, in both, the mango and in the melon inoculated with both bacteria. The analysis found that the mango inoculated with *E. coli* had a devastating effect (death at day 0).

Dry matter, matter balance and sensory analysis were determined to have a better conclusion of the investigation.

Keywords: Haden Mango (*Mangifera indica*), Melon cantaloupe (*Cucumis melo*), clove (*Syzygium aromaticum*), cinnamon (*Cinnamomum verum*), sodium benzoate, bactericide, conservation, *E. coli*, *Salmonella.*

Introduction:

The present work aims to evaluate the bactericidal property of cinnamon, clove and sodium benzoate in the preservation of tropical fruits such as mango and melon. It also aims to determine the balance of matter in the fruits studied and to analyze the sensory behavior of the fruits subjected to the treatment with cinnamon, cloves and sodium benzoate. Research entitled "Study of the bactericidal effect of clove, cinnamon and sodium benzoate in the preservation of Haden mango and melon", carried out with basic grant funds from the National Autonomous University of Honduras, developed in the facilities of the Western Regional University Centre. Within the framework of scientific research, the axis on Environment, biodiversity and development, where the aim is to generate scientific knowledge regarding the valuation of the environment and its biodiversity, as well as the direct repercussions on the conditions and quality of life, health, food security; being the contribution of our research in the priority theme of food and nutritional security in the pillars of biological use and consumption.

Can cinnamon and cloves be conservation alternatives in processed foods from tropical fruits such as mango and melon, inhibiting and/or eliminating bacteria of pathogenic origin present naturally or inoculated in the process of handling them?

In the western region, small artisanal businesses are beginning to develop that do not have the technical knowledge of sanitation and hygiene, of the handling of post-harvest agro-industrial products, so it is hoped to provide them with a support tool to achieve the safety of the processes they develop.

Fruits are usually contaminated by bacteria such as Escherichia coli and Salmonella spp. and therefore it is necessary to apply preventive bactericidal products to avoid the growth of these bacteria in these products.

In previous studies carried out in other countries, it has been determined that cinnamon; cloves and sodium benzoate have had bactericidal effects in different foods. It is considered necessary to study mango and melon, which are favorite fruits in Honduran gastronomy and for export, and it is also necessary for processors to acquire certain basic knowledge of the existence and control of bacteria in processed products.

In the contributions of the research, the bactericidal effect of clove was minimal in mango inoculated with E. coli, and in mango inoculated with Salmonella spp. There was no bactericidal effect, in the case of melon inoculated with both bacteria, the bactericidal effect of clove was observed. The bactericidal effect of cinnamon was minimal in both fruits inoculated with E. coli. In mango inoculated with Salmonella spp. there was no bactericidal effect, but in melon it had a lethal effect. The use of sodium benzoate exerted a bactericidal effect on both melon and mango inoculated with both bacteria. In the analysis it was observed that in the mango inoculated with E. coli the effect was fulminant (death on day 0). In the case of the melon treated with clove, it had fewer acceptances as it had a negative impact on the color, which became darker. Similarly, in the

case of melon treated with sodium benzoate, the taste of this chemical was detected and the color of the fruit was positively intensified.

In the case of mango, the most acceptable treatment was the one treated with clove, in terms of taste and aroma, although the color became darker. The mango treated with cinnamon was accepted to a lesser extent than the clove treatment, but the color was more intense. The mango treated with sodium benzoate was the sample with the lowest acceptance in taste and aroma, which, as in the case of melon, the taste of the chemical used was detected, although the color was intense.

The novelty criterion of the research is that in history it has been used as a species for culinary processes, so we want to demonstrate that it also has antiseptic properties that can be a preservative and/or natural preservative, since nowadays the food industry worldwide requires food with cleaner processes, eliminating chemical synthesis additives.

Likewise, the use of tropical fruits, typical of the area and their study, will generate new results and knowledge in food safety, which will be useful for the country's fruit processing companies and the generation of scientific technical knowledge for academia in studies of agro-industrial transformation processes.

Mango and melon will be the first experiments, as similar studies have been designed in other countries but with different foods, according to their importance in the region.

Currently, Honduras has become an exporter of mango and melon, which is why the study of these tropical fruits is of utmost importance.

Referring to reports from the FDA about the alleged detection of Salmonella in melons from Honduras, the US Food and Drug Administration has issued a new alert about the importation of melons produced in Honduras, contaminated with salmonella, Honduran authorities informed. The director of the National Animal Health Service (SENASA), Edmundo Toro, said that the FDA's information is "very scarce", and so far it is not known in which US port the affected Honduran melon were found.[1]

By carrying out experimental activities it is of utmost importance to find or validate hypotheses on the efficiency of clove and cinnamon vs. some preventive uses such as sodium benzoate, experiments carried out with two of the most important fruits of our country, such as mango and melon, both fruits with different characteristics in nutritional value and pH, in order to have a criterion of the organoleptic environment studied in both fruits, to achieve better results in the research.

The research aims to provide a basis for food preservation and safety in products made using raw materials such as tropical fruits grown in the country, for which experimental activities were carried out in the chemistry and biology laboratory at CUROC, with the aim of achieving research results, The aim was to determine the bactericidal effect of the natural substances present in cinnamon and cloves, and thus determine their efficiency in inhibiting the growth and/or elimination of bacteria such as Salmonella and Escherichia coli, bacteria that can be present in products made from mango and melon when good manufacturing practices are not followed in the handling process.

Currently, mango and melon are tropical fruits mainly consumed in the national and international market in fresh state, although they can also be used to elaborate different transformed presentations, such as mango juices and nectars, which in turn can be used to make mixtures of tropical fruits, which are preferred in the European market (FAO 1997). (FAO 1997) Frozen mango slices, dehydrated mangoes, mango preserves (purees, jellies, jams and syrup) can also be produced, which are mainly consumed in the foreign market. These agro-industrial derivatives can be used as

[1] Disponible en http://www.freshplaza.es/article/8702/EEUU-FDA-detecta-supuesta-salmonella-en-melones-de-Honduras

bases for ice cream, ice cream and soft drinks, baby food, confectionery and sweets. In general, in the case of concentrated and frozen pulp for direct consumption and pastry decoration, in the case of frozen slices.

Therefore, it is considered necessary to carry out a study to check the bactericidal effect of cinnamon and cloves on ripe Haden mango and melon, which would be a cleaner and less costly conservation alternative for processors of these fruits, both for the national and international market.

This research will serve as support for the artisanal processors in the western part of the country who are starting out in this activity, in addition to the research part, it will generate new knowledge in academic support for students studying agro-industrial engineering and agricultural engineering.

Food consumption has been defined as the capacity of the population to make appropriate decisions on how to select, store, prepare, distribute and consume food at the individual, family and community levels. Food consumption is closely related to the customs, beliefs, knowledge, food practices and educational level of the population[2], but in all these variables the purpose is to achieve food safety to ensure food and nutritional security. For this reason it is important to know that, during harvesting, the surface macrobiotic of vegetables and fruits comprises mainly gram-negative bacteria, such as Escherichia coli and Salmonella spp, enteric bacteria involved in major foodborne outbreaks worldwide, causing symptoms of gastroenteritis, and even chronic infections (D'Aoust, 2007; Francis et al., 1999).

In addition, it is important to mention that the upturn in crops is due to the fact that producers have become aware of how to manage them, the retentions of containers due to pests have so far been nil, and this is the result of a series of training courses given to farmers in order to achieve quality products". The areas where most vegetables and fruit are grown are Comayagua; the western zone, the municipality of Florida, Copán and Tocoa in the department of Colón, and melon specifically in the southern zone. (Press, 2013)

Mango (Mangifera indica):

This fleshy, tasty and refreshing fruit is also known as the "peach of the tropics". It is the most important member of the Anacardiaceae or cashew family, genus Mangifera, which comprises some 50 species, native to Southeast Asia and surrounding islands, except for Mangifera africana which is found in Africa. It is now recognized as one of the three or four finest tropical fruits. (European Union, 2013)

Taxonomy and morphology of mango.

Mango (Mangifera indica) is one of the most popular tropical and subtropical fruits consumed in both fresh and processed forms. India is the largest producer of mango in the world, however, its export is very limited mainly due to poor shelf life of the fruit (Burg and Burg, 1962; Krishnamurthy et al., 1971; Cua and Lizada, 1990; Ramos and Srivastava, 1999*).* [3]

Morphology and taxonomy of melon.

Melon, Family: Cucurbitaceous, scientific name: Cucumis melo L. Plant: herbaceous annual, creeping or climbing habit, root system: abundant, highly branched and fast developing. Main stem: covered with hairy formations, with nodes on which leaves, tendrils and flowers develop, with new stems sprouting from the leaf axils. Leaf: ovate orbicular blade, reniform or pentagonal, divided into 3-7 lobes with toothed margins. The leaves are also hairy on the underside. Flower: the flowers

[2] LA SEGURIDAD ALIMENTARIA Y NUTRICIONAL EN HONDURAS
COALICION DE INSTITUCIONES QUE TRABAJAN EN SAN
HONDURAS, 2005

[3] Burg, S.P. y Burg, E.A. **(**1962). Role of ethylene in fruit ripening. Plant Physiol. 37: 179–189.

are solitary, yellow in color and can be male, female or hermaphrodite. The male flowers usually appear first on the lowest internodes, while the female and hermaphrodite flowers appear later on the second and third generation branches, but always together with the male flowers. The number of male, female and hermaphrodite flowers and the time of their appearance are greatly influenced by the level of fertilizer. Pollination is entomophilous. Fruit: its shape is variable (spherical, elliptical, ovate, etc.); the green, yellow, orange, white, etc. rind can be smooth, reticulated or striated. The flesh may be white, yellow, creamy, orange, salmon or greenish. The placenta contains the seeds and may be dry, gelatinous or watery, depending on its consistency. It is important that it is small so that it does not detract from the pulp of the fruit and that the seeds are well placed in the placenta so that they do not move during transport. (infoagroCopyright infoagro.com, 2017)

In Honduras, vegetable and fruit exports, which had fallen in 2012, are recording a significant upturn so far in 2013 and have almost tripled the number of containers sent abroad, according to exporters and government representatives. At the national level, the cultivation of non-traditional products such as pulses, vegetables and fruits, as a whole, last year recorded revenues of 110 million dollars (Prensa, 2013). Exports of melon and watermelon alone brought in $51 million in foreign currency for the state, while pulses and vegetables registered some $60 million, making them two products of great importance in the national economy. Vegetables are also the third most important agricultural product in Honduras, and the Comayagua Valley is the main niche for these crops and a variety of tropical fruits. (Prensa, 2013)

Therefore, minimally processed vegetables are now in high demand in today's consumer market (Sloan, 2005)[4].

The most important reason for sales of minimally processed vegetables and fruits relates to convenience and speed of preparation (Ragaert et al., 2004). In Western Europe, processed fresh vegetables represent an increasing share of the total fresh produce market with an estimated growth of 10-25% per year since 1990 (Ragaert et al., 2004). Mango is one of the best-selling tropical fruits in Europe and its marketing as fresh-cut fruit is gaining importance in the market. However, fresh-cut fruits have a very short shelf-life due to difficulties in preserving their quality as fresh produce (Beaulieu and Lea, 2003; Soliva-Fortuny and Martín-Belloso, 2003). Processing mechanisms, such as sorting, peeling, pulping and crushing, cause the cutting of the cellular rupture, with the consequent release of enzymes and substrates, resulting in a higher rate of physiological reactions. Moreover, bruised surfaces and intensive handling provide favourable conditions for the growth of micro-organisms. The main signs of undesirable quality loss are changes in colour through enzymatic browning, reduction of firmness in texture, development of bad taste and growth of pathogenic microorganisms (Brecht, 1995; Baldwin et al, 1995; Watada et al, 1996; Soliva-Fortuny and Martín-Belloso, 2003). Nowadays, it is becoming increasingly important for consumers to eat foods that, in addition to the original benefits they provide, help them to maintain their health and prevent disease. For this reason, an increasing percentage of the world's fruit production is being used in functional food production processes (Milacatl, 2003). In order to achieve safe products using natural substances for the preservation of these products such as mango and melon.

Escherichia coli:

The E. Coli, which normally inhabits the intestine of humans and warm-blooded animals, is a Gram-negative bacterium typical of the Enterobacteriaceae family, with facultative anaerobic respiration inside the intestine and aerobic respiration outside (Huang et al., 2000). E. coli is a thick, short bacillus, 0.4 to 0.7 microns thick and 1 to 4 microns long, motility varies with culture media, does not form spores, is gram negative and uniformly stained by aniline dyes, and has no

[4] Sloan A.E. (2005). Top ten functional food trends. Food Technology 59(4): 20–32.

characteristic intimal structures. E. coli is part of the normal flora of the large intestine in man and animals. Some strains of E. coli are pathogenic in nature and can cause enteric infection or extra-intestinal disease; these pathogenic strains have been grouped into six different groups or categories: enteropathogenic E. coli (EPEC), enterotoxigenic E. coli (EPEC), enterotoxigenic E. coli (EPEC), enterotoxigenic E. coli (EPEC) and enterotoxigenic E. coli (EPEC). coli enterotoxigenic (ETEC), enteroinvasive E. coli (EIEC), enterohaemorrhagic E. coli (EHEC), enteroaggregative E. coli (EAEC), diffusely adherent E. coli (DAEC), of which ETEC and EHEC are the most prevalent. E. coli infections cause 630 million cases of diarrhoea in humans worldwide and approximately 775,000 deaths per year, mainly affecting children in developing countries. (Nataro, and Kaper, 1998); (Wang, et al., 1997).

Salmonella:

The genus Salmonella belongs to the family Enterobacteriaceae. Members of the genus Salmonella are gram-negative bacilli, 0.7-1.5 x 2.0-5μm, usually motile by peritrichous flagella (except S. gallinarum), facultative anaerobes, non-sporulating. They do not ferment lactose (except S. enterica subep. arizonae and S. enterica subsp. diarizonae), ferment glucose with gas production (except S. typhi); do not produce indole; do not degrade urea; decarboxylate lysine and ornithine. (Bopp et al., 1999), It is found in raw poultry, eggs, beef and sometimes in unwashed fruits and vegetables (USA, 2017). Food products that have undergone adequate heat treatment during processing are generally free of the pathogens. However, epidemiological investigations in outbreaks related to various ready-to-eat products have shown that the presence of Salmonella spp. in frequently consumed products is due to post-process recontamination (Reij and Den Aantrekker, 2004). In these products, mainly affected by surface contamination. Antimicrobial packaging could avoid the need to add large amounts of antibiotics to food and reduce the reduction of antimicrobial activity due to interactions with food constituents. (Appendini and Hotchkiss, 2002).

Sodium benzoate:

The main cause of food spoilage is attack by different types of microorganisms (bacteria, yeasts and moulds). The problem of microbial food spoilage has obvious economic implications, both for manufacturers (spoilage of raw materials and processed products before marketing, loss of brand image, etc.) and for distributors and consumers (spoilage of products after purchase and before consumption). Sodium benzoate is also known as sodium benzoate, sodium benzoate, sodium salt of benzoic acid, sodium salt of benzene-carboxylic acid; sodium salt of dacrylic acid; sodium salt of phenyl-carboxylic acid. A white, crystalline or granular salt of benzoic acid, formula C6H5COONa. It is soluble in water and slightly soluble in alcohol. The salt is antiseptic and is generally used to preserve food. (Sauceda, 2011)

There is a worldwide trend towards increased consumption of fruit and vegetables, mainly motivated by a growing concern for a more balanced diet, with a lower proportion of carbohydrates, fats and oils and a higher share of dietary fibre, vitamins and minerals. This is partly due to the lower calorie requirements of modern life, characterised by greater comfort and sedentary lifestyles. However, the trend is increasingly to consume products that are fresher and healthier, and as close to their original form as possible. This is because the consumption of chemical preservatives has been associated with poisoning, cancer and other degenerative diseases, such as benzoates, nitrites and nitrates, sulphur dioxide (SO2), among others. This generates the need to look for conservation alternatives that cover the same antimicrobial properties and compatibility with the food (Álvarez-Parrilla, 2005). Cited by (Sauceda, 2011).

Culinary herbs to study their preservative properties:

Many other medicinal properties have been found in cinnamon. In folk medicine it is used to treat rheumatism and other inflammations. Its anti-inflammatory, antispasmodic and anti-coagulant properties are believed to be due to its cinnamaldehyde content. Cinnamon extracts are active against Candida albicans, the fungus responsible for vaginal yeast infections, as well as Helicobacter pylori, the bacterium responsible for stomach ulcers. Cinnamon's antimicrobial properties are thought to be due to eugenol and a cinnamaldehyde derivative. Cinnamon extracts also inhibit the growth of tumour cell cultures. This effect may be due to the presence of procyanidins and eugenol in the bark extract. Cinnamon is also useful as a food preservative to inhibit the growth of common foodborne bacteria such as Salmonella and E. coli. (https://alimentos.org.es/canela, current)

Clove is used for stomach upset and as an expectorant. Expectorants help expel phlegm when coughing. Clove oil is used for diarrhoea, hernias and bad breath. Clove and clove oil are used for intestinal gas, nausea and vomiting.

Cinnamon

Cinnamon was previously used to preserve food, as its fungicidal, bactericidal or bacteriostatic properties killed or inhibited the growth of organisms that could spoil food. Its preservative function is demonstrated in the balsams used by the Egyptians to preserve mummies. Most of its composition consisted of spices such as cinnamon, cassia and myrrh. In the West, cinnamon is used as an ingredient in sauces, some dishes such as mole and especially in desserts such as creams, mousses, custards, rice pudding, rice pudding, cakes, capirotada, tamales, torrijas, pudding, cinnamon ice cream, etc.. In the East and Arabia it is also used in cooking. Because of its sweet, warm and penetrating aroma, it gives an excellent flavour to coffee, gruel and of course to tea, which can be taken either alone as in a black cinnamon tea or accompanied by lemon or apple. In the East it is often mixed with other spices such as cloves or cardamom. More uses of cinnamon, The liquor industry uses cinnamon as an ingredient to flavour liqueurs. The fragrance industry uses it in the preparation of perfumes and toilet soaps. One more is in the decorative area, especially in handicrafts, flower and fruit arrangements. To ensure that cinnamon retains its special aroma for a longer period of time, it should be stored in tightly closed glass jars in a dry place.

Research methods:

Mango and melon were purchased in the municipal market of Santa Rosa de Copan, with a uniform quality, they were processed, peeled cut and pulped, a balance of matter was carried out, the samples were weighed in fresh and processed states to determine the percentages of composition of the parts of the mango fruit. Samples were then prepared for treatments and controls. The strains of the microorganisms to be studied (Escherichia coli and Salmonella spp.) that were used in the research were obtained by making arrangements with the central microbiology laboratory. An experimental study was carried out to determine the growth or destruction phase of the pathogens with three replicates in controls and treatments, using the method of quantification or colony-forming unit (CFU) count on plate on the selective media for each bacterium studied.

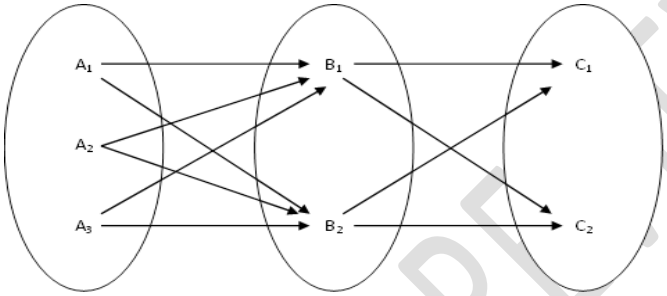
Sample collection:

The samples analysed in the present work were the pulp of Mango, Mangifera indica L., family, botanical: Anacardiaceae, taking the samples of mango fruit and Cantaloupe melon (Cucumis melo), to the laboratory, it is necessary to follow the processing steps to obtain the pulp, the operation of sample preparation for microbiological analysis, requires very strict aseptic handling rules, as well as the use of sterile material and dilutions, to avoid external contamination of the food.

Media used: Eosin methylene blue agar (EMB agar). Selective differential medium for the isolation of coliforms in water is used as a differential medium for the isolation and differentiation of Gram-

negative enteric bacteria. XLD, Medium (Ph. Eur.) Used for the isolation of pathogenic Enterobacteriaceae, mainly Salmonella and Shigella, from biological samples and foodstuffs.

Experimental design:

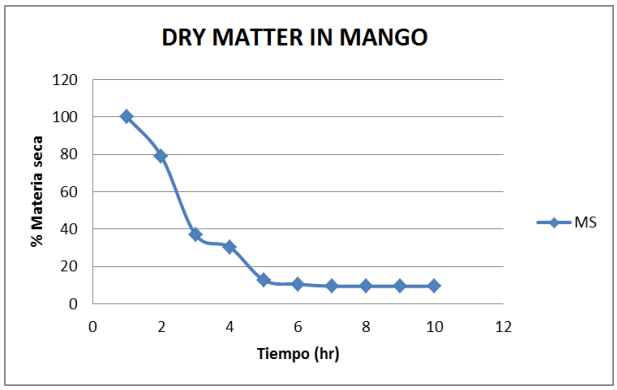


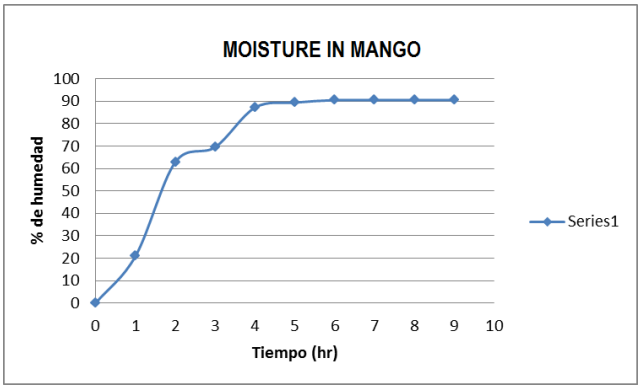
Where:

C1 = Cinnamon, B1 = Mango, C1 = Escherichia coli, Cl2 = Clove, B2 = Melon, C2 = Salmonella, B3 = Sodium benzoate. Treatments: A1 B1C1, A1 B1C2, A1 B2C2, A1 B2C2, A1 B2C2, A2 B1C1, A2 B1C2, A2 B2C1, A2 B2C1, A2 B2C2, A3 B1C1, A3 B1C2, A3 B2C1, A3 B2C2 and controls Control B1C1, Control B2 C1, Control B1 C2 and Control B2 C2.

Results:

The accepted method for the determination of the percentage dry matter is by drying the sample in a (vacuum) oven at 110°C until consecutive weights made at 2-hour intervals vary by less than 3 mg (AOAC Methods 1980). Although several samples can be dried at any one time, this method has the disadvantage of usually requiring samples to be dried overnight to complete the test. Microwave drying technology has its merits due to its speed, simplicity, low cost and repeatability, but results in localised drying and provides high variability in drying times depending on power settings and sample type.



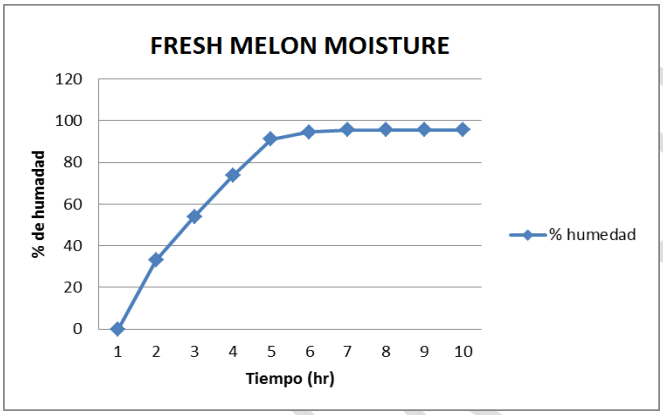


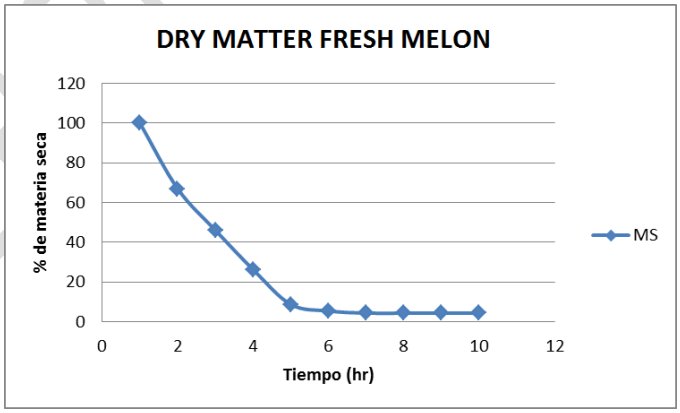
GRAPH 1. PERCENTAGE OF MOISTURE IN MANGO.

CHART 2. PERCENTAGE OF DRY MATTER IN MANGO.

It is observed that in 10 hours the sample lost 90.51% of humidity, which remained constant from the sixth hour of heat treatment at a constant temperature of 105 °C.

It is determined that the frozen mango pulp has a 9.49% of dry matter, as can be seen in the graphs,





results of three repetitions.

GRAPH 3. PERCENTAGE OF MOISTURE IN MELON.

GRAPH 4. PERCENTAGE OF DRY MATTER IN MELON.

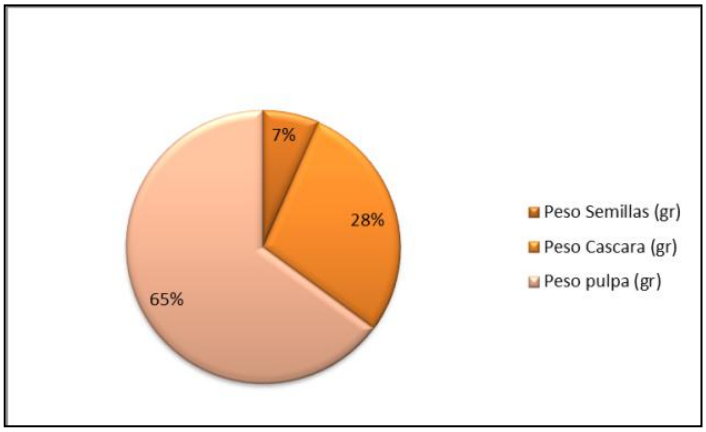
It is observed that in 10 hours the sample lost 95.60% of moisture, which remained constant from the sixth hour of heat treatment at a constant temperature of 105 °C. It is determined that the melon pulp in its fresh state has 4.40% dry matter, as can be seen in graph 4.

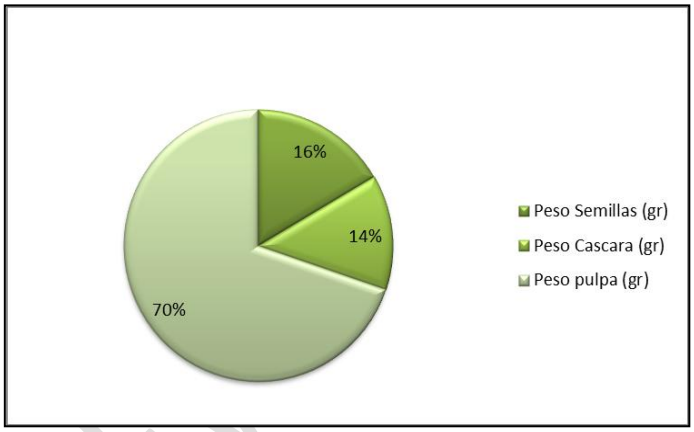
It is determined that the melon pulp in fresh state has a 4.40% of dry matter, as can be seen in the graph No. 4. For this analysis, 4 samples were used, which were averaged for the respective graph.

Mass balance of mango (Mangifera indica) variety Haden and melon (Cucumis melo) variety cantaloupe.

The mass balance is the main calculation within the food industry, it will help to control quantities of raw material entering and leaving the processes. It makes it easier to identify the amount of finished product that will be obtained from a given amount of raw material. (Lomas 2002).

The mango and melon fruit was processed to prepare the samples, both the controls and the samples to be treated with clove, cinnamon and sodium benzoate, the fresh fruit was weighed to determine the total weight, then the fruit was peeled and the epicarp (skin or peel of the fruit) was weighed, The fruit was then sliced, leaving only the endocarp (seed or stone) in the case of mango and the seeds in the case of melon, to which the weight was determined, and finally the mesocarp (pulp) became the problem sample for the present study.





GRAPH 5. MATERIAL BALANCE IN MELON

The 35% of the melon represented by weight of the seed and peel are considered waste, but could be used in the elaboration of animal feed, as well as organic fertiliser for plants. The largest percentage of the melon fruit represents 65% of the pulp used in the food industry.

GRAPH 6. MATERIAL BALANCE IN MANGO

The 30% of the mango fruit represented by weight of seed and peel are considered waste, but could be used in the production of animal feed, as well as organic fertiliser for plants. The largest percentage of the mango fruit represents 70% of the pulp used in the food industry.

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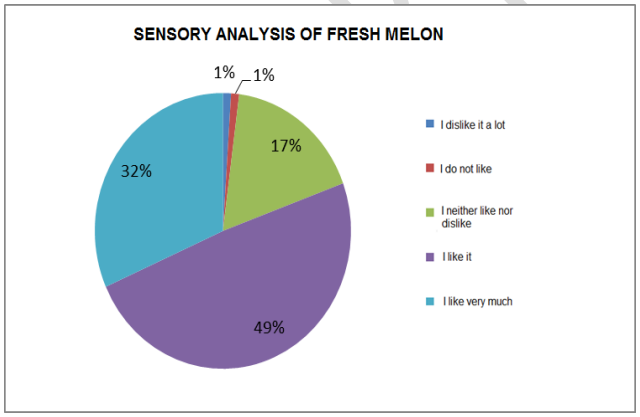
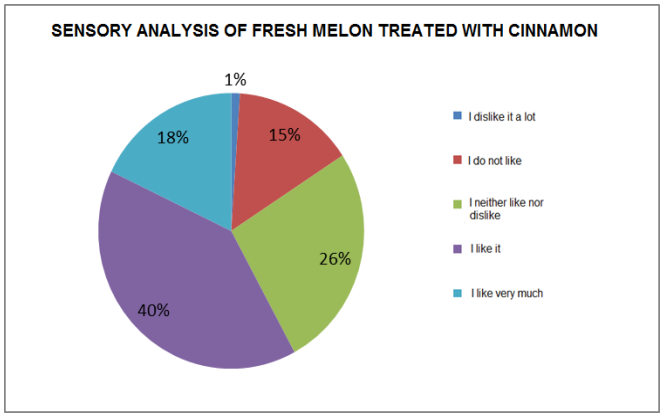
Fresh melon treated with cinnamon, cloves and sodium benzoate was tasted, as well as fresh fruit without any treatment



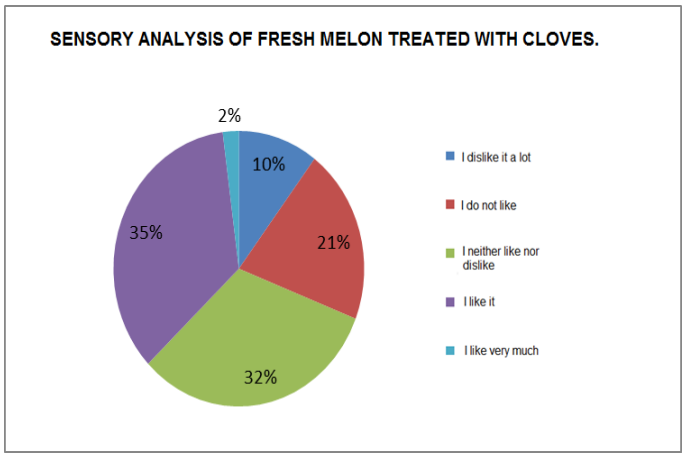


GRAPH 7. SENSORY ANALYSIS, FRESH MELON WITHOUT TREATMENT GRAPH

81% of the tasters approved the taste, aroma and characteristic colour of this fruit, highlighting the aroma and flavour. 98% of the tasters approved the organoleptic characteristics of the fresh melon, the flavour being the most outstanding sensory characteristic of the sample.

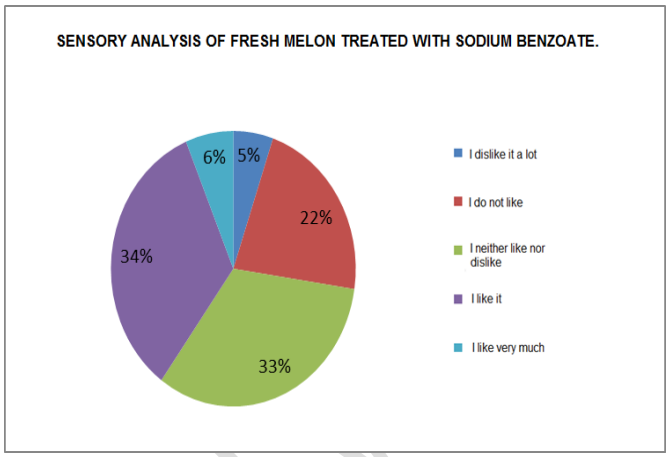
8. SENSORY ANALYSIS. MELON-CINNAMON

Only 58% of the tasters perceived the taste and aroma of cinnamon as acceptable, the overall approval of melon plus cinnamon was 84%, and not acceptable 16%.



GRAPH 9. SENSORY ANALYSIS, MELON-SCENTED CLOVES.

Clove was perceived and accepted by the tasters in an overall 69% accepted and 31% rejected.



GRAPH 10. SENSORY ANALYSIS, SODIUM BENZOATE.

Melon plus sodium benzoate treatment, overall acceptance was 73% and rejection of the chemical was 27%.

Results of laboratory analysis:

MANGO - E. COLI.

According to the summary table with mango and E. coli bacteria, the following results were obtained: the control showed constant growth up to day 7 and decreased to 2 log10 on day 15.

The mango - E. coli - clove treatment showed constant growth up to day 7 and decreased to 3 log10 on day 15, as did the mango - E. coli - cinnamon treatment.

A different situation occurred with mango - E. coli - sodium benzoate, which on day 0 showed a decrease of 9 log10.

MANGO - SALMONELLA.

In the mango - Salmonella control, constant growth was observed until day 7. The same situation was observed in the mango - Salmonella - clove, mango - Salmonella - cinnamon treatment, which decreased by 4 log10 on day 15.

Very different situation with the sample treated with sodium benzoate which on day 7 decreased by 9 log10.

MELON - E. COLI.

In the E. coli control, growth remained constant until day 15.

In the melon - E. coli - clove treatment, it decreased by 4 log10 on day 7, which remained constant until day 15.

In the melon - E. coli - cinnamon treatment, it remained constant on day 7, and decreased to 3 log10 on day 15.

In the melon - E. coli - sodium benzoate treatment, until day 7, it remained constant and decreased its growth to 5 log10 on day 15.

MELON - SALMONELLA.

In the control it remained constant until day 7, decreasing its growth to 3 log10 on day 15.

In the Melon - Salmonella - Clove treatment, its growth decreased to 5 log10 on day 7 and to 6 log10 on day 15.

In case of melon - salmonella - cinnamon the growth remained constant until day 7, and decreased to 6 log10 on day 15. The same effect was observed in the melon - salmonella - sodium benzoate treatment.

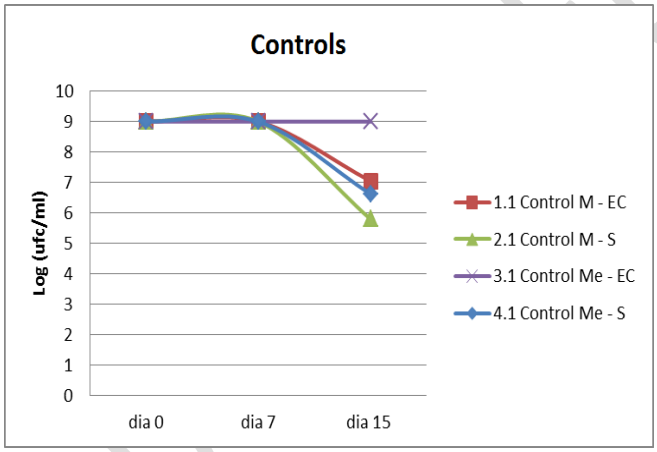


Figure 1. Research controls.

Figure 1: Controls inoculated with pathogenic bacteria Escherichia coli O157 and Salmonella enteritidis in Mango Haden and Melon.

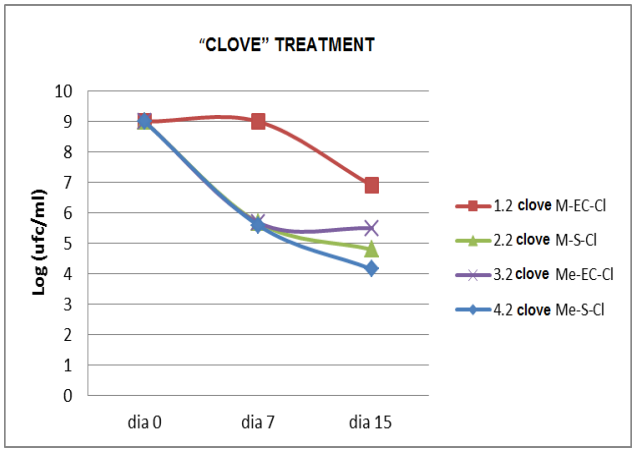


Figure 2. Clove treatment.

Figure 2: Effect of clove at 5% concentration on the growth of Escherichia coli O157 and Salmonella enteritidis in Mango Haden and Melon.

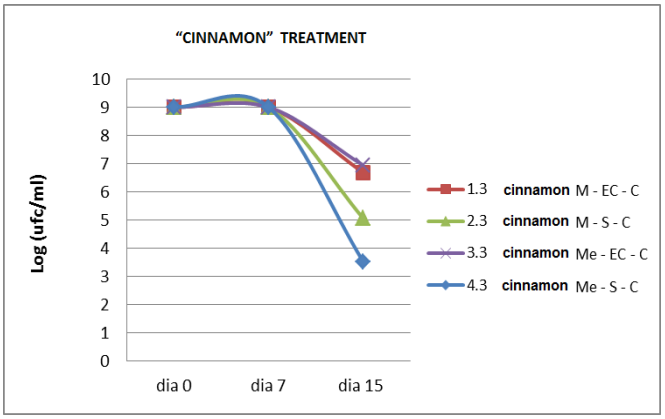


Figure 3. Cinnamon treatment.

Figure 3: Effect of cinnamon at 5% concentration on the growth of Escherichia coli O157 and Salmonella enteritis's in Mango Haden and Melon.

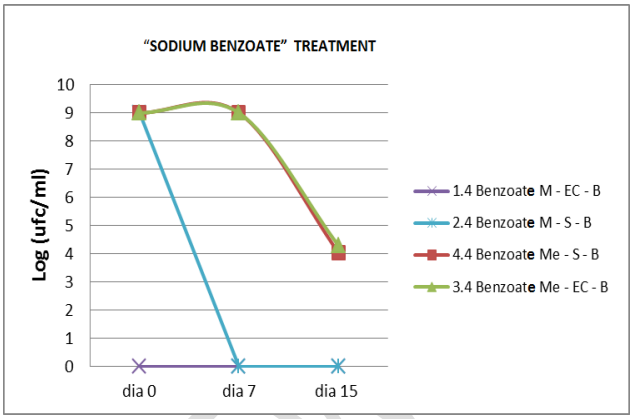


Figure 4. Sodium benzoate treatment.

Figure 4: Effect of sodium benzoate at a concentration of 0.1% on the growth of Escherichia coli O157 and Salmonella enteritis's in Mango Haden and Melon.

TABLE 1. SUMMARY OF TREATMENTS AND RESULTS.

Concentration	**(2.5%)**	**(2.5%)**	**(0.1%)**
Control M - EC	**M-EC-Cl**	**M-EC-C**	**M-EC-B**
Constant day 7, day 15 2 log10.	15 days 3 log_{10}.	Constant day 7, 15 days 3 log_{10}.	Day 0, 9 log_{10}.
Control M - S	**M-S-Cl**	**M-S-C**	**M-S-B**
Constant day 7, Day 15 4 log_{10}.	15 days 4 log_{10}.	Day 7 constant, day 15 4 log_{10}.	7 days 9 log_{10}.
Control Me - EC	**Me-EC-Cl**	**Me-EC-C**	**Me-EC-B**
Constant 15 days.	7 days 4 log_{10},	Day 7 constant, day 15 3 log_{10}.	7 day constant, 15 day 5 log_{10}.

	Constant after 15 days.		
Control Me - S	**Me-S-Cl**	**Me-S-C**	**Me-S-B**
Constant day 7, dya 15 3 log.	7 days 5 log_{10}, 15 days 1 log. Plus (total 6 log.)	Day 7 constant, 15 day 6 log_{10}.	7 day constant, 15 day 5 log_{10}.

Not effective

Treatment Minimal effect

Lethal treatment

Fulminant treatment

Conclusions:

1. The bactericidal effect of clove was different in the two treated fruits; in mango inoculated with E. coli a minimal effect was observed and in mango inoculated with Salmonella spp. there was no bactericidal effect. In the case of melon inoculated with both bacteria, the bactericidal effect of clove was observed.

2. The bactericidal effect of cinnamon was minimal in both fruits inoculated with E. coli. In mango inoculated with Salmonella spp. there was no bactericidal effect, but in melon it had a lethal effect.

3. The use of sodium benzoate exerted a bactericidal effect on both melon and mango inoculated with both bacteria. In the analysis it was observed that in the mango inoculated with E. coli the effect was fulminant (death on day 0).

4. 35% of the weight of the melon is represented by the seed and rind, which are considered waste, but could be used in the production of animal feed, as well as organic fertilizer for plants. The largest percentage of the melon fruit represents 65% of the pulp used in the food industry. In the analysis of the dry matter of the pulp, it was observed that in 10 hours the sample lost 95.60% of moisture, which remained constant from the sixth hour of treatment, at a constant

temperature of 105 °C. Therefore, we observed that the high moisture content of this fruit is an ideal environment for the development of bacteria.

5. 30% of the mango fruit is represented by the weight of the seed and peel, which are considered waste, but could be used in the production of animal feed, as well as organic fertilizer for plants. The largest percentage of the mango fruit represents 70% of the pulp used in the food industry. In the analysis of the dry matter of the mango pulp, it was observed that in 10 hours the sample lost 90.51% of moisture, which remained constant after six hours, heat treatment at a constant temperature of 105 °C, therefore, like the melon, it has an ideal environment for the development and growth of bacteria.

6. In the sensory behaviour of the fruits subjected to the treatment of cinnamon, clove and sodium benzoate, it was observed that the melon treated with cinnamon had greater acceptance by the group of tasters, both in colour, flavour and aroma. In the case of the melon treated with clove, it was less accepted as it had a negative impact on the colour, which became darker. Similarly, the melon treated with sodium benzoate had the taste of sodium benzoate and the colour of the fruit was positively intensified. In the case of mango, the most acceptable treatment was the one treated with clove, in terms of flavour and aroma, although the colour became darker.

7. The treatment of mango with cinnamon was less accepted than the one treated with cloves, but the colour was more intense. The mango treated with sodium benzoate was the sample with the lowest acceptance in flavour and aroma, which, as in the melon, the taste of the chemical used was detected, although the colour was intense.

Suggestions

1. The use of sodium benzoate should be tested in lower concentrations, together with cinnamon and cloves, and aqueous extracts of these spices, which are natural sources of sodium benzoate.

2. Encourage farmers to produce and process different spices that can be used as preservatives in foodstuffs, as no aqueous extracts of the spices used could be found during the research project.

3. To study the bactericidal power of other different spices existing in the country.

4. In this type of scientific research, more time is needed from the researcher, who should be in a condition of exclusivity, as it is necessary to increase the number of repetitions per treatment, in order to obtain more reliable results.

5. It is necessary to improve the conditions of the facilities, equipment and laboratory material for microbiology and food processing.

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