POST COLLECTS VALORIZATION OF PAPAYA (*Carica papaya* L.): SYRUP CONSERVATION.

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Abstract

Preserving nutritional values of a fruit can alleviate many problems caused by malnutrition. Therefore, the ability to reduce postharvest losses of tropical fruits brings us to the search of a technique that preserves the papaya (*Carica papaya* L.) fruit. The implementation or practice of papaya preservation technique can enable the optimal use of harvested papayas; the syrup barrier technique will be used for the preservation of papaya. The syrup-preserved papayas underwent a series of tests in order to determine their nutritional and organoleptic qualities. Syrup pulps are made from the local sunrise variety of Togo papayas and the Solo N° 8 papayas. Based on the conservation technique, two groups of syrup-preserved pulps were prepared for each variety and separated into batches. The fruits were analyzed before and after being preserve at room temperature (27 ± 1°C). For all batches, measurements were related to the parameters regarding the flavor like the sugar rate of the pulps which represents the main soluble dry extract (SDE), evaluated in degree Brix (°Brix); assayable acidity of both fresh and syrup-preserved pulps; the water content of pulps; and mineral salts and ascorbic acid content of papaya pulps, have been determined. Beside, during and at the end of the preservation process, microbial evolution characteristics and sensory evaluations were checked. The obtained results show that the study characteristics vary according to varieties and the covering liquid after the preservation except the acidity. Variations in soluble dry extract (SDE) contents are significant. Organoleptic property tests reveal that both light syrup-preserved and medium-concentrated syrup-preserved fruits are successfully conserved.

Key words: Preservation, fruits, syrup, nutritional qualities.

Résumé

VALORISATION POST RECOLTE DE LA PAPAYE (*Carica papaya* L.) : CONSERVATION AU SIROP.

La reconnaissance d'un fruit dont les aptitudes nutritionnelles peuvent pallier en partie aux nombreux problèmes causés par la malnutrition mais également la possibilité de la réduction des pertes post récolte des fruits tropicaux ont amené à la recherche d'une technique de conservation de la papaye (*Carica papaya* L.). L'utilisation optimale des papayes récoltées se fera par la mise en place d'une technique de conservation de la papaye ; la technique de barrière des fruits au sirop sera empruntée pour réaliser des conserves de papaye au sirop. Les papayes au sirop mises en conserve ont subi différents tests afin de s'assurer de leurs qualités nutritionnelles et organoleptiques. Des papayes de la variété Sunrise cultivée au Togo et celles de la variété Solo N° 8 ont été utilisées pour la fabrication des pulpes au sirop. Selon la technique de conservation, deux (2) catégories de pulpes au sirop ont été réalisées pour chaque variété et regroupées par lots. Les fruits ont été analysés avant la mise en conserve et au terme de la mise en conserve à la température ambiante du laboratoire (27 ± 1°C). Pour tous les lots de papayes, les mesures ont porté sur les paramètres caractérisant la saveur à savoir : le taux de sucre de la pulpe qui représente le principal extrait sec soluble (ESS) qui est évalué en degré Brix (°Brix), l'acidité titrable de la pulpe fraîche et au sirop, la teneur en eau des pulpes, la teneur en sels minéraux et la teneur en acide ascorbique des pulpes de papaye ont été déterminées. En outre, pendant et au terme de la conservation, les caractéristiques de l'évolution microbienne et les évaluations sensorielles ont été faites. Les résultats obtenus ont montré que les caractéristiques étudiées variaient en fonction des variétés et du liquide de couverture après conservation des pulpes sauf l'acidité. Les variations observées des teneurs en extrait sec soluble (ESS) sont significatives. Les signes d'une bonne conservation conférés par les propriétés organoleptiques analysées sont aussi évidents sur les fruits conservés au sirop léger qu'au sirop moyen.

Mots-clés :Conservation, fruits, sirop, qualités nutritionnelles.

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INTRODUCTION

In order to highlight the full content in minerals with papaya, fruit of papaya tree (*Carica papaya* L.), and to ensure its nutritional needs regarding the fight against malnutrition, this work aims at presenting a preservation technique of it. Ranking third among tropical fruits, it is the most sold on worldwide market (FaoStats, 2016). In 2013, its worldwide production was approximately 12, 5 million tons, the largest producer being India (5.54 million tons), followed by Brazil (1.58 million tons) and Nigeria (773.000 tons) (FaoStats, 2016). Unlike other tropical fruit trees, papaya tree bears fruit all year long; however, like all tropical fruits, its postharvest loss percentage remains very high, about 10 to 80% (Coursey and Booth, 1972; Jeffries and Jeger, 1990; Paull, 2001). As far as papaya fruit is concerned, the losses are generally characterized by quick deteriorations caused by various shocks to its marrowy texture and some other diseases. Papaya acquires its organoleptic and nutritive properties during its maturing process (N'da et al., 1996; Hewett et al., 2006; Lechaudel and Joas, 1996). It is rich in calcium, iron and vitamins A, B and C (N'da et al., 1996; Hewett et al., 2006; Lechaudel and Joas, 1996). The organoleptic properties of fresh consumed fruits depend on their physiological state at harvest time. The extreme fragility and inadequate handling technique of papaya during transportation and the ignorance of consumers are the stumbling blocks or challenges that face the sector professionals (Loeillet and Imbert, 2008). This study mainly aims at developing a suitable conservation technique that helps to optimize papaya shelf-life.

MATERIALS AND METHODS

VEGETABLE MATERIALS

Selection of papaya varieties

The two most common types of papayas available in the local markets were selected, that is the Sunrise variety which grows easily in Togo of which fruits weight between 765g and 950g; and the Solo variety N° 8 originating from Cote d'Ivoire and which was imported from Ghana. Solo papayas weight between 310g and 345g. This selection comprises both green and ripe papayas (Codex Stan 193).

Fruit selection and pretreatments

In order to reach the same weight, 15 Sunrise papayas and 25 Solo N°8 papayas, ripe or green, are used to prepare 50 pulps in syrup. Prior to their preservation, they underwent a series of pretreatments which consist of minimizing microbial proliferation and after having undergone careful selection, washing, peeling, trimming and seeding removal stages. A homogenous shape is added to the quality of the final product.

Additives

Papaya preservation needs ingredients like sucrose, clarified lemon juice and also flavoring elements such as vanilla and cinnamon (not essential for preservation).

METHODS

Preservation with syrup

The bottling stage is preceded by the pasteurization of the jars and their lids in boiling water at a temperature of 90°C during 30 minutes. The steamer is then dried and cooled at 60°C.

Fruits are placed and packed but not squashed, in conditioning jar cleaned in advance. Left spaces between fruits while filling up the container are completed by the hot syrup.

During the pre-heating stage, containers filled with fruits and covering syrup are placed in a boiling water bath, in a saturated steam atmosphere with lids simply placed not tightly closed. The jars' content is brought to 75°C (70-80°C) during around 10 minutes. The sugar used is sucrose and there are two (2) types of syrups, the light one with a concentration comprised between 14 and 18°Brix and a medium concentrated one ranging from 17 to 20°Brix.

In each batch of 50 syrup-preserved papayas, 15 have been randomly selected for testing. Four batches of fifteen (15) syrup fruits corresponding to each of the two types of preservation liquid had been used for each studied variety. Criteria to assess papaya quality are evaluated from the supplying moment to the end of the preservation process, at room temperature (28 ± 2°C). These criteria include total sugar, ascorbic acid, mineral salts, pulp acidity, microbiological profile and sensorial evaluation of bottled fruits in syrup.

Physicochemical and biochemical tests

With both types of liquids, these tests are conducted on 3 batches of papayas: fresh, green and ripe fruits. Pulp sugar rate represents the main Soluble Dry Extract (SDE). It is measured in °Brix from a homogenate filtrate, at 28 ± 2°C, using a precision refractometer consistent with the ISO 2173 norm [1978]. The acidity of the pulp in the above-mentioned extract is measured with an electronic pH-meter. In consistency with the French standard ISO 665[2000], the water content is assessed through heating/stoving. The content in mineral salts is gauged in a mineralized extract by molecular absorption spectrophotometry in consistency with French standard V08-060 [1996]. The method described by Deymie et al. (1981) (Deymie and Simon, 1981) is used to check the ascorbic acid content (vitamin C).

Microbial tests and sensory evaluations

In addition, the microbial evolution characteristics are registered two times: from the beginning to the end of the conservation process. The total number of mesophyll flora and coliforms, the thermo tolerant coliforms, the anaerobes sulfite-reducers, the fecal streptocoques, the yeasts and moulds as well as the *Staphylococcus aureus* are counted, using the required methods and standards. Besides, characteristics of microbial evolution have been defined 7 days into the conservation process and at its completion, i.e. 30 days of conservation.

The "Preference Order" test and the "Notation of Quality" test are used for the sensory assessment of pieces of ripe and green papaya of Sunrise and Solo 8 varieties preserved in medium-concentrated and light syrups. The organoleptic properties of the various types of conservations obtained from papaya pulps were evaluated in an anonymous way. These evaluations were carried out in comparison with the variety of papaya and the type of syrup used. The assessment panel was composed of hundred informed people divided into two groups. The "Preference Order" test and the "Notation of Quality" test were used. The "Preference Order" test was used in the development and the improvement of new products and for advertising purposes. By contrast, the quality scale test or the "Notation of Quality" test is used in quality control and has made it possible to establish distinctive parameters like texture, the level of sugar, acidity, etc. These two tests underscore the authenticity which is the conservation of the main physical, chemical, organoleptic and nutritional characteristics of the original fruit in the final product as well as the quality of the final product [Lawless and Heyman,1999; AFNOR, 2000; Frandsen et al, 2007).

RESULTS

Soluble Dry Extract (SDE)

As far as fresh fruits are concerned, the free glucid content of the two varieties taken at various stages of maturity is in a closed interval from 10 to 12.2 Brix degrees (Figure 1).

The variation in free glucid content is not too important when one considers the gauged values in each category of papaya: fresh papayas, light syrup-preserved papayas and medium-concentrated syrup-preserved papayas. Nevertheless, a significant increase in free glucid (p< 0.001) is observed between fresh pulps and syrup-preserved pulps. The average of free glucid content for the light syrup-preserved pulps is about 16°Brix, while the medium-concentrated syrup-preserved pulp is approximately 21°Brix significantly different according to both groups (p< 0.001) If the increase is about three to four °Brix when one moves from fresh fruits to light syrup-preserved fruits of local papayas and to the ones preserved in medium-concentrated syrup, an increase of eleven 11° Brix difference is noted between the SDE of fresh fruits and the SDE of the N° 8 Solo variety preserved in medium-concentrated syrup. Consequently, the Solo papaya in medium-concentrated syrup offers the highest SDE (22° Brix).

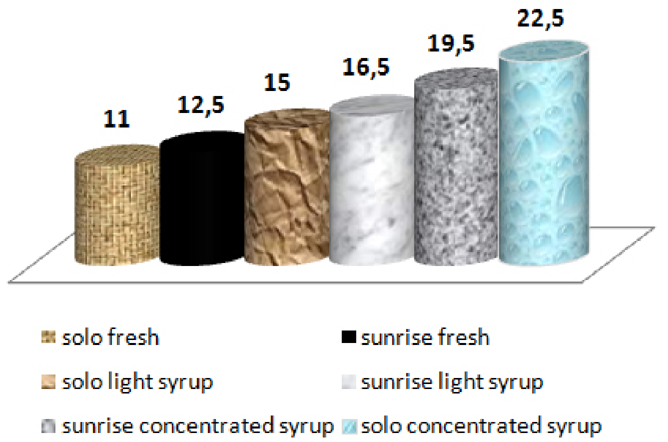

Figure 1: Comparative diagram of free glucid rates (°Brix)

Acidity

The pH acidity of fresh pulps has an average value of 5.7. The use of clarified lemon juice as acidifier and conservative has had a noticeable effect on assayable acidity. One notes a significant acidification (minus 1. 60 units of pH) of all pulps preserved in the syrup where acidity averages is 4.17 (Figure 2).

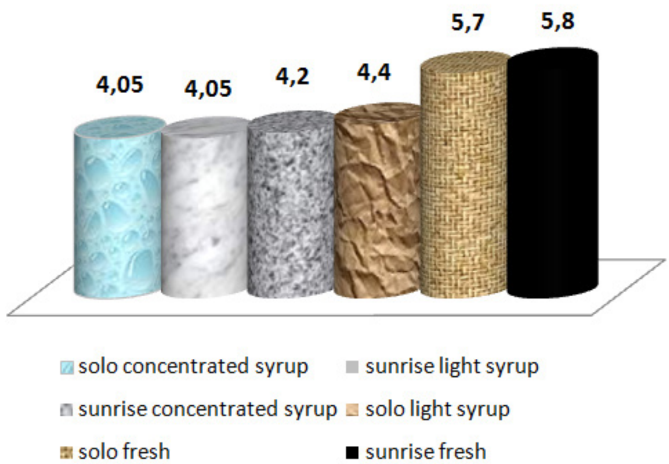

Figure 2: Comparative diagram of acidity (pH)

Water content

The highest water content, which is more than 90%, is found with local pulps in light syrup. Regardless to all varieties, the statistical comparison of both fresh and preserved pulps in all types of syrups reveals no difference in water contents, however.

Ascorbic acid content

Both varieties of papayas under consideration, Sunrise and Solo 8, have important contents of vitamin C; their fresh pulps provide an average value of 88 mg for 100 g per fresh fruit. The anticipated post-conservation decrease in content reveals not only significant differences between both groups but in the fresh pulps as well (Figure 3). While the Sunrise pulps keep about 60% of their ascorbic acid molecules (vitamin C) content in light- and medium-concentrated syrups, the Solo 8 pulps lose from 50 to over 65% of their ascorbic acid molecules when preserved in light- and medium-concentrated syrups respectively. A statistical analysis shows a significant difference between pulps of the same variety preserved in different types of syrups as well as between pulps of different varieties preserved in the same type of syrup (p<0.001).

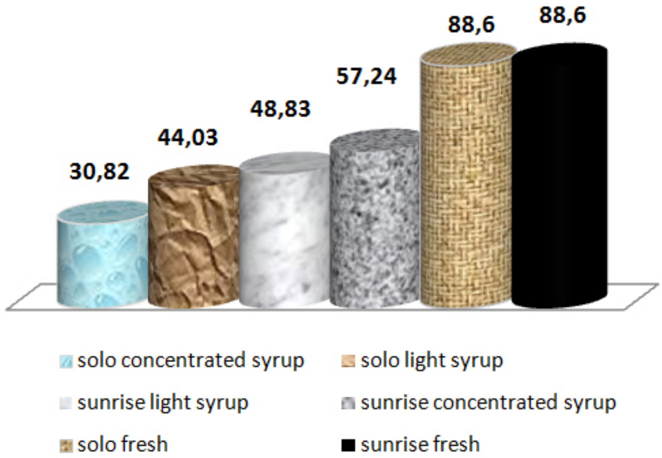

Figure 3: Comparative diagram of ascorbic acid (mg/100g)

Mineral salts content

Test of mineral salts contained in fresh pulps (Table 1) reveals that ripe Sunrise variety has the highest content of all mineral salts, and especially calcium, iron and potassium. Metal macro-elements such as potassium, calcium and magnesium make of a fresh papaya a rich fruit whatever the variety, since some oligoelements such as iron and manganese are equally well represented in papayas. The cooking (heat treatment) will cause a drop in different proportions of these two types of elements (Tables I and II). There is a drop of more than 75% of potassium in the syrup-preserved Sunrise pulps. The decrease rate of calcium in light syrup-preserved Sunrise is 22% from its initial value; it is 36% in medium-concentrated syrup. Magnesium keeps nearly 60% of its initial rate/value in syrup-preserved Sunrise; the rate is about 76% in medium-concentrated syrup. The rate of manganese drops more than one-third; iron preserves more than 80% of its initial value in both light- and medium-concentrated syrup-preserved Sunrise. Potassium decreases more than 50% in the Solo pulps. Iron preserves more than 50% of its initial value in light syrup-preserved Solo and more than 80% in medium-concentrated syrup. When preserved in light syrup, there is a magnesium conservation of 52.1% for the Solo variety but a loss of about 60% is noticed when the same Solo variety is preserved in medium-concentrated syrup. Paradoxically, little change occurs in the initial value of calcium when it comes to the Solo preserved in the two types of syrups while an 8.25% rise in manganese is noted in light syrup-preserved Solo.

In conclusion, both varieties show no differences when it comes to mineral salts conservation. Likewise, there exists none between the preserved pulps, regardless of the syrup type.

Table I : Mineral salt content of 100g of fresh papaya pulp.

Mineral salt (mg/100gFW)	Green Sunrise	Ripe Sunrise	Green Solo	Ripe Solo
Potassium	1872	1880	1279	1348
Calcium	400	560	200	360
Magnesium	120	504	504	576
Iron	22.4	24	12	21.5
Manganese	26.53	20.9	42.5	21.5

Table II : Mineral salt content of 100g of ripe papaya pulp preserved in syrup.

Mineral salt (mg/100gFW)	Sunrise light syrup	Sunrise concentrated syrup	Solo light syrup	Solo concentrated syrup
Potassium	475	450	650	425
Calcium	440	360	300	300
Magnesium	276	384	390	240
Iron	19.67	19.34	11.57	17.75
Manganese	12.9	13.2	23.275	12.5

Microbiological tests

The microbiological tests were conducted on the 7th and 30th days (after production) on samples randomly drawn from a batch. Microbiological tests reveal a lack of effective pathogens. The germs found are Molds and mesophyll flora. However, a meticulous observation after four weeks of storage reveals the absence of fungal and bacteria.

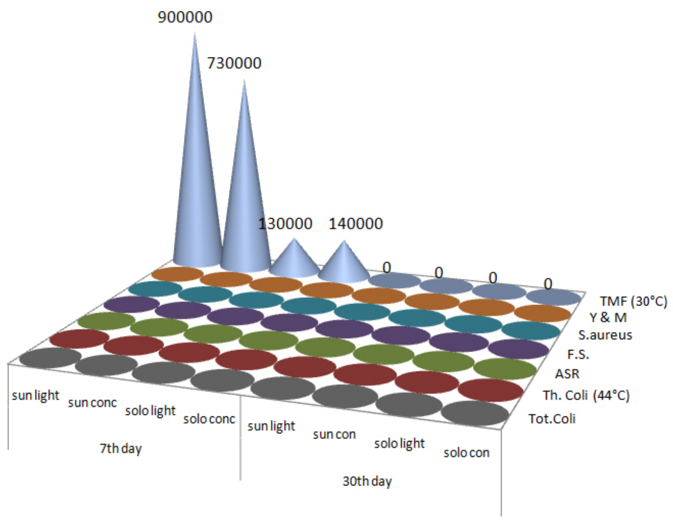

Figure 4: Microbiological evolution of papaya's pulps preserved in syrup for 30 days

sun light: papaya preserves of local variety **sun**rise in **light** syrup; **sun con**: papaya preserves of local variety **sun**rise in medium **con**centration syrup; **solo light**: papaya preserves of **Solo** variety in **light** syrup; **solo con**: pawpaw preserves of **Solo** variety in medium **con**centration syrup. **TMF**: Total Mesophyll Flora; **Y&M**: Yeasts and moulds; **S. aureus**: *Staphylococcus aureus*; **F.S.**: Fecal staphylococci; **ASR**: Anaerobe sulfite reducers; **Th. Coli**: Coliformes heat-resisting, **Tot. Coli**: Totals Coliformes.

Sensory tests

Sensory tests are used to assess the organoleptic characteristics of the finished product. The average organoleptic ratings from the test score and assessment of all the samples chosen give a general idea about each organoleptic feature regarding both conservation sensory tests of each of the varieties of papaya and then with regard to whole set with each variety in both tests. It appears from a graphic comparison of the Sunrise variety and the Solo variety in light syrup that the Sunrise offers an attractive appearance and flavour, making it the most popular item (Figure 5). The difference is most pronounced at the texture level. In terms of global preference with regards to the pulps in medium-concentrated syrup, the Solo variety is preferred to the Sunrise variety. Again, the big difference has to do with the texture (Figure 6).

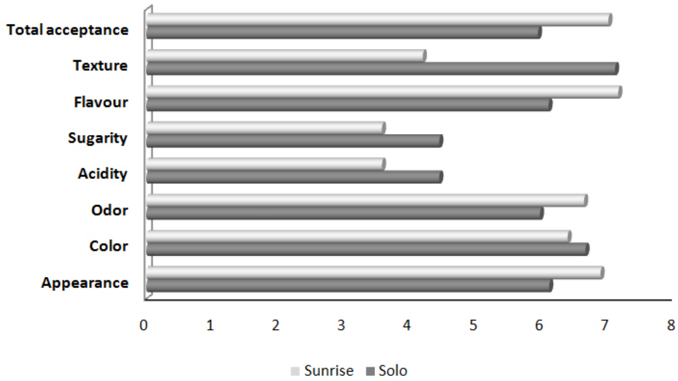

Figure 5: Organoleptic qualities of papaya pulps preserved in light syrup

Resulting from the "Preference Order" test, the local Sunrise papaya in light syrup ranks first; it is followed by the Solo papaya in medium syrup, the local Sunrise papaya in medium syrup, and the Solo papaya in light syrup.

The quality scale test which provides more details on the sensory parameters shows that different types of papayas in syrup coming from both papaya varieties and different types of syrups reveal differences between them. There exists no significant difference between the conservation of both varieties of papayas when it comes to color and flavour (smell). A highly significant difference in acidity ($p<0.001$) exists between the Solo papaya pulps and the local papaya pulps; the Solo pulps stored in the two types of syrups are more acidic than those of the local papaya in syrup. It is important to note that the different syrups are made with exactly the same amount of clarified lemon juice.

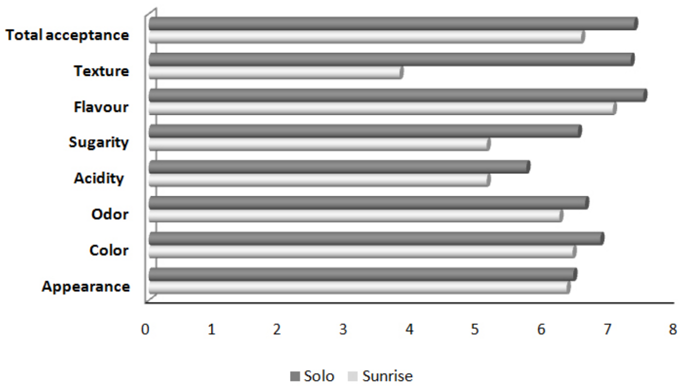

Figure 6: Organoleptic qualities of preserved papaya pulps in medium-concentrated syrup

The difference observed in sweetness is equally significant; sugar transfer is most successful with the Solo pulps than with the local ones. Resulting from acidity and sweetness, the flavour is the same in the different types of conservation of both varieties of papayas (Figures 5 and 6). Additionally, the quality scale test reveals a difference in texture between the Sunrise and the Solo 8 pulps preserved in both types of syrups. However, although a sizable disparity exists in the overall conservation processes of Solo 8 and Sunrise papaya and especially with reference to the type of syrup, this difference is negligible. There is, therefore, the same global appreciation for both varieties in both types of syrups.

DISCUSSION

Food preservation techniques are mainly based on the exploitation of barriers principle which aims at preserving the quality and safety of food. The principle of physicochemical conservation techniques chosen here is based on modifying the intrinsic characteristics of food by the pH, the lowering of water activity (*Aw*) through the use of syrups. Deliberate association and smart treatment to ensure stability, security and food quality seem to be an extremely effective method for provoking homeostatic responses from micro-organisms, while keeping the desired sensory and nutritional characteristics (Leitsner and Gould, 2002; Gould, 1995; Alzamora et al, 1998; Leitsner, 2000). Thus, for the papaya conservation in the form of a canned fruit in syrup, the technique called “technical barrier” or “combination of techniques” is used by bringing together the pH effects, water lowering effects, and moderate heat treatment effects. High moisturized foods like papaya require a special technology of barriers carefully designed for it alone. Kept by the interaction between water activity and gentle heat and pH treatments, high moisturized fresh fruits that can be stored without refrigeration is the resultant of a rational application of a combined approach (Welti-chanes et al, 2000; Alzamoa et al., 2000; Codex 51, 1998). Consequently, the technology of barriers underscores the development of stable foods in the environment while requiring just a minimum energy.

Transfer of sugars is done more efficiently in high sugar-concentrated syrup. Consequently, the levels of SDE well correlate with the type of syrup used for pulp conservation. It should be noted, however, that the Solo pulps tend to accumulate more (Alzamora et al, 2000; Argaiz et al, 1995). The carbohydrate free load found here is in line with the norm set by the *Alimentarius Codex* (Codex 51, 1998). The choice of moisturizer depends upon several factors such as its cost, its ability to lower water activity, , its solubility and its impact on the organoleptic features of the finished product (CTA, 1990). Mainly made up of sugar, the syrup equally plays a crucial moisturizing role by reducing the water activity used as a barrier. As is the case here, low weight molecular saccharides (glucose, fructose, sorbitol) promote sugar intake by allowing easy penetration of molecules (Alzamora et al, 2000; Argaiz et al, 1995). Thus, the main processing effect resides in bringing an input of solid instead of dehydration. Traditionally, salt and sucrose solutions are used as humectants in the making of fresh food at intermediate and high humidity rate (Jayaraman KS, 1995). Syrup is equally instrumental in maintaining the physicochemical properties during storage of the finished product as it prevents the denaturing of fruit flavours. For some time now, other solutes such as glycerol, glucose, fructose, corn syrups, sorbitol, dextrose, and lactose are used as humectants in the making of new food products (Alzamora et al, 1995). But when it comes to fruits, sugars such as glucose, fructose, sucrose and other polyols like glycerol are chosen as humectants (Welti-Chanes et al, 2000). Drawn entirely from fruits, a concentrated fruit juice can also be used as osmotic solution, creating a sweeter finished product (FAO, 1988; In 1988, FAO proposed techniques relating to fresh products with high humidity, recommending the use of sulfites in very small quantities in order to inhibit non-enzymatic browning and prevent the growth of yeasts and moulds; bacterial growth being inhibited by the interaction between water activity, pH and enzymes inactivated by a whitening high temperature (Guerrero et al, 1996). When compared to sorbates, it is found that sulfites get poorer in fruit-based stored foods, even faster and more completely, thereby losing their effectiveness as a barrier against non-enzymatic browning and the development of fungi (FAO, 1988; Santé Canada, 2005).

The technique called “technique of barrier” or “combination of techniques” is used for the canning of papaya in the shape of syrup fruit; it consists in combining pH effect, lowering water effect, and moderate heat treatment effect. pH is one of the most important barriers to fresh food with high humidity rate, for in addition to determining both the types of organisms that can grow and their growth rate, pH remains instrumental in the activity of preservatives and the stability of many vitamins. In general, the pH of canned fruits should be as low as taste allows. Fortunately, fruits tolerate substantial pH reductions without losing their flavour. The acidulate used for the experiments, clarified lemon juice, fully played its role of preservative without altering the papaya flavor nor allowing intake of any other acidulate. The choice of acidulate is factor of the type of fruit, the cost, the sugar/acidity balance, etc. Citric acid, the most commonly recommended brand, is used to prevent enzymatic browning, since it inhibits the polyphenol oxidase by reducing the pH and by chelating copper at the site of enzyme activity (references). In this case study, however, clarified lemon juice has played the role of barrier and preservative with no other adjuvant added, generating, in the end, a finished fresh product without additives but devoid of pathogenic microorganisms (CTA, 1990).

The increase in acidity after heat treatment is caused by the use of clarified lemon juice as acidulant and preservative. The Solo pulps are the most noticeably acidified. So papaya varieties react according to the acidification level typical to the preparation of canned fruits: it is mandatory to take this into account when preparing preservative.

Rich in vitamin C, papayas contain an average of 64 mg of vitamin C per 100 g of fresh fruit; ascorbic acid levels measured in the fresh pulps of both varieties of papaya under study are 30-60% higher (Loeillet and Imbert, 2008). The expected decrease in ascorbic acid is caused by the effect of heat treatment, given the heat-labile features of vitamin C. However, losses in the Solo pulps are higher. This difference in preservation could be due to the ability of variety fibers to fix vitamin C in with heat and sugars (References). It should be noted, however, that all vitamin C-related contents are within an acceptable range for the nutritional needs that is, ranging from 31 to 58 mg per 100 g of pulp in syrup, the highest content level being found in the Sunrise pulps preserved in medium syrup.

Despite the success of conservation, it must be noted that mineral salts are the most affected when compared to physicochemical parameters. Nevertheless, by comparing the results of nutritional values of fresh and preserved pulps, all values obtained after dosing (physicochemical parameters and mineral concentrations) are much higher than the standards (Bruneton, 1999). This could be caused by the differences in varieties and, therefore, be explained by the presence of ecotypes in the evolution of species and the relative wealth of the soil (Moll and Moll, 1998).

Microbiological testing permitted to check the effectiveness of each of the two barriers used in the technique applied. Only after a minimum of seven days were the high acids-and-sugars combined concentrations able to neutralize the germs present in the preservatives following their preparation. Preheating (or blea c hing) is instrumental in traditional conservation methods. Heat treatment has two main functions here: to destroy enzymes that can damage the vegetables and fruits when app1ying the techniques of minimum transformation; and to reduce the initial microbial load by inactivating heat-sensitiv e microorganisms (Codex Stan 247, 2005). The applied t emperature levels are lethal to yeasts as well as to most m olds and aerobic micro organisms. In traditional methods where chemical additives are employed, bleaching and the addition of sorbates and sulfites or other chemical antimicrobial agents reduce the microbial load by 60 to 99% (Santé Canada, 2005; Moll and Moll, 1998).

Conducte d anonymously via prefe rence order and quality scale tests, sensory assessment reveals that even kept in syrup, papaya could be identified and obviously meet authenticity test. Despite the general preference for all samples remains the same in the wake of the preference order test, the Sunrise sample in light syrup is the most preferred.

The make - up of the syrups prim arily accounts for the differences noted in the texture of acidity and sweetness during the quality scale test, but the papaya variety equally creates these differences. Both Sunrise and Solo varieties are gifted with sugar accumulation and acidification qualities specific to each of them. The difference observed at the texture level is equally the result of the variety of papaya; since the local papaya is naturally softer than the Solo papaya, cooking still adds temperature effect to it, which greatly softens its texture.

CONCLUSION

Papaya p r eservation is a very daunting challenge when it comes to its conservation duration time, making long-term projecti o ns a difficult task. Tests conducted in the course of this study revealed that papaya, regardless of its variety, contains a full range of minerals, including potassium, calcium, and vitamin C. Though syrup conservation undermines the concentration in nutritional values of papaya, analysis of the physicochemical parameters shows that the remainin g concentration is important enough to ensure daily nu t ritional needs and help effectively fight against malnutri t ion. At agro-alimentary level, this study equally undersco r es that both varieties have intrinsic and specific abilities for sugars accumulation, acidification, and calcium retention. The two selected types of syrups have enabled the conservation of papaya pulps for 30 days at room temperature and the microbiological analyses show the effectiveness of the barrier technique used to inhibit the growth of germs. The success of the technical process is proven by microbiological and sensory evaluation tests. Regarding organoleptic property evaluation, the pulps preserved in both types of syrups with no additives during 30 days are equitably assessed in relation to the difference of the type of syrups and the variety of papaya; conserva t ion in medium-concentrated syrup is assessed as well as that preserved in light syrup.

REFERENCES

1. **FAOStats** 2016 [http://faostat3.fao.org/]
2. **Coursey DG and RH Booth**The postharvest phytopathology of perishable tropical produce. *Rev. Plant Pathol.* 1972 ; **51** : 751-765.
3. **Jeffries P and MJ Jeger**The biological control of postharvest diseases of fruits. *Postharvest News Inform.*1990; **1** : 365-368.
4. **Paull RE** Advances in postharvest technology for tropical and subtropical fruits. **In**: Proceedings of the International Technical and Trade Seminar on Tropical and Subtropical Fruits. 2001.
5. **N'da Adopo A, Lassoudiere A and J Tchango Tchango** Importance du stade de récolte pour la commercialisation du plantain au Cameroun. *Fruits* 1996 ; **51**: 397-406.
6. **Hewett EW** An overview of preharvest factors influencing postharvest quality of horticultural products. *Int. J. Postharvest Technology and Innovation.* 2006 ; **1**(1): 4-15.
7. **Lechaudel LM and J Joas** Quality and maturation of mango fruits of cv. Cogshall in relation with harvest date and carbon supply. *Austral. J. of Agri. Res.*2006 ; **57**: 419-426.
8. **Loeillet D and E Imbert** La papaye.*Fruitrop.* 2008 ; **160** : 22-23
9. **Codex Stan 183**Norme Codex pour les papayes. Codex Alimentarius 1993, Révisée. 1-2001, Amendée. 1-2005.
10. **Deymie B, Multon JL and D Simon** Analyses des constituants alimentaires **In** : Lavoisier (Ed). Techniques d'analyse et de contrôle dans les industries agro-alimentaires. APRIA. Paris (France): Tec et Doc. 1981.
11. **Lawless H and H Heymann**Sensory evaluation of food. Principles and practices.Gaithersburg, Maryland : Aspen Publisher, Inc. 1999.
12. **AFNOR** Norme XP V09-500. Directives générales pour la réalisation d'épreuves hédoniques en laboratoire d'évaluation sensorielle ou en salle en conditions contrôlées impliquant des consommateurs. **In** : AFNOR, recueil de normes, Analyse sensorielle. 6ème édition. 2000.
13. **Frandsen LW, Dijksterhuis GB, Brockhoff P, Nielsen JH and M Martens** Feeling as a basis for discrimination, : comparison of a modified authenticity test with the same-different test for slightly different types of milk. *Food Quality and*

Preference. 2007; **18**: 97-105.

14. **Leitsner L and GW Gould** Hurdle Technologies. Combination Treatments for Food Stability, Safety and Quality. Kluwer Academic/ Plenum Publishers, New York, USA. 2002.

15. **Gould GW** "Overview" **In:** GW Gould (Ed). New Methods of Food Preservation. Blackie Academic and Professional, London. 1995; 15-19.

16. **Alzamora SM, Tapia MS and J Welti-Chanes** New strategies for minimal processing of foods: the role of multitarget preservation. *FoodSci. and Tech. Int.* 1998; **4**: 353-361.

17. **Leitsner L** Hurdle technology in the design of minimally processed foods **In:** SM Alzamora MS Tapia and A López Malo (Eds). Minimally Processed Fruits and Vegetables.Fundamental Aspects and Applications. Aspen Publishers, Inc., Gaithersburg, MD, USA. 2000; 13-27.

18. **Welti-Chanes J, Alzamora SM, López-Malo A and MS Tapia** Minimally processed fruits using hurdle technology **In:** GV Barbosa-Cánovas and GW Gould (Eds). Food Preservation Technologies: Innovations in Food Processing. Technomic Publishing Co., Inc., Lancaster, Pennsylvania, USA. 2000; 123-148.

19. **Alzamora SM, Fito P, López-Malo A, Tapia MS and E Parada-Arias** Minimally processed fruit using vacuum impregnation, natural antimicrobial addition and/or high hydrostatic pressure techniques **In:** SM Alzamora, MS Tapia and A López Malo (Eds). Minimally Processed Fruits and Vegetables. Fundamental Aspects and Applications. Aspen Publishers, Inc., Gaithersburg, MD, USA. 2000 c; 293-315.

20. **Codex cac/gl 51** Directives du Codex Alimentarius pour les milieux de couverture des fruits en conserve Codex Alimentarius, 2003.

21. **Vidales SL, Castro MA and SM Alzamora** The structure-texture relationship of blanched glucose impregnated strawberries. *FoodSci. and Tech. Int.*1998; 4: 169-178.

22. **Alzamora SM, Castro MA, Vidales SL, Nieto AB and D Salvatori**The role of tissue microst*ructure in* ***the textural*** **characteristics of** minimally processed fruits **In:** SM Alzamora, MS Tapia and A López Malo (Eds). Minimally Processed Fruits and Vegetables. Fundamental Aspects and Applications. Aspen Publishers, Inc., Gaithersburg, MD, USA. 2000 b; 153-171.

23. **Argaiz A, López-Malo A and J Welti-Chañes** Considerations for the development and stability of high moisture fruit products during storage **In** : J Welti-Chanes and G Barbosa-Cánovas (Eds). Food Preservation by Moisture Control - Fundamentals and Applications. Technomic Pub. Co., Lancaster, USA. 1995 ; 729-760.

24. **CTA.**Conservation des Fruits à Petite Échelle CTA - ILO - WEP. 1990.

25. **Jayaraman KS** Critical review on intermediate moisture fruits and vegetables. **In** : J Welti-Chanes and G Barbosa-Cánovas (Eds). Food Preservation by Moisture Control - Fundamentals and Applications. Technomic Pub. Co., Lancaster, USA. 1995; 411-442.

26. **Alzamora SM, Cerrutti P, Guerrero S and A López-Malo** Minimally processed fruits by combined methods. **In** : J Welti-Chanes and G Barbosa-Cánovas (Eds). Food Preservation by Moisture Control - Fundamentals and Applications. Technomic Pub. Co., Lancaster, USA. 1995; 463-492.

27. **FAO.**United Nations Food and Agriculture Organization, Agriculture : Service de technologies d'ingénierie agricole et alimentaire. Technologies combinées de conservation des fruits et légumes. 1988.

28. **Guerrero S, Alzamora SM and LN Gerschenson** Optimization of a combined factors technology for preserving banana purée to minimize colour changes using the response surface methodology. *J. of Food Engineering*. 1996; **28**: 307-322.

29. **Santé Canada**Fichier canadien sur les éléments nutritifs, 2005.

30. **Bruneton** J Pharmacognosie - phytochimie, plantes médicinales Editions Tec α Doc, Editions médicales internationales.1999.

31. **Moll N and M Moll** Additifs alimentaires et auxiliaires technologiques - chimie et santé, Masson (Ed).Paris. 1998.

32. **Codex Stan 247** Norme générale Codex pour les jus, les nectars et autres dérivés de fruits Codex Alimentarius. 2005.