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RESEARCH ARTICLE

Valorization of sweet bananas (*Musa sinensis*) by drying after osmotic dehydration

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Abstract

The aim of the current study was to identify the suitable treatment mode for the preservation of sweet bananas (*Musa sinensis*) by drying after osmotic dehydration. Therefore, banana samples of 1cm of thickness were dehydrated with different sugar solutions with or without salt at three different temperatures (25°C, 45°C and 60°C) and the greatest water losses were subjected to air drying at 45 and 60°C. It comes out from the survey that the best dehydrations were observed for the solutions binary of saccharose at 50 °Brix and ternary of saccharose at 50 °Brix and NaCl (5 %) with water losses of more than 30%. After drying, the results obtained for ash, vitamin C, color and texture showed that the samples dehydrated before drying as well as possible preserve more the nutritional and physical qualities of banana.

INTRODUCTION

The fruits had always a great importance in the human feeding. They constitute a source of energy and nutritive substances for growth, phenolic vitamins, minerals, anti-oxidizing phenol and other bioactive substances (Albitar, 2010; Aminzadeh *et al.*, 2010). Benin country as an undeniable producer or supplier of fruits is unfortunately little developed. This lack of industrial valorization and the problems involved in the conservation cause approximately 25 to 50% of loss post-harvest according to the product (Ahouannou *et al.*, 2010; Bchir, 2011). Thus, the sweet banana of variety *Musa sinensis*, known for its brittleness due to its strong water content, occupies like many of other fruits, a significant share of these post-harvest losses.

The dehydration-impregnation by immersion (DII) or osmotic dehydration (OD) is a method able to increase the lifetime of the foodstuffs for the purpose of new and appreciated sensory properties to them. It brings an appreciation to the product, facilitates marketing (conditioning) and thus allows of it, the marketing of products of diversification, which for could change the routine in the mode of consumption of the fruits (Jiokap *et al*., 2001a; Bchir, 2011). Moreover, it is a technique of conservation using less energy and which proceeds under transferable technological conditions in country medium, because of the simplicity of their implementation (Jiokap *et al*., 2001a; Ndjouenkeu, 2003). Indeed, Certain countries of Africa in the south of the Sahara, like Senegal and Cameroun developed techniques of conservation by the osmotic dehydration (OD) of the foodstuffs with strong water content during these last year's (Jiokap *et al*., 2001a). However, the products resulting from OD are not enough stable. In consequence, this process is often followed of a complementary treatment like thermal drying. Indeed, in the developing country, drying is the mode of preservation of the foodstuffs more used (N'goran, 2012).

As, many work undertaken on the various fruits they showed as the combination of thermal drying and by the DII, can increase the shelf life of the fruits and improve their quality (Jiokap, 2002; Ndjouenkeu, 2003; Fernandes *et al*., 2006). It would result from this a widening from the range from the fruits treated with a diversification from the characteristics from the products obtained and the development from new products. With these various assets, the DII combined with the thermal drying of sweet banana of variety *Musa sinensis*, would be an interesting alternative.
In order to contribute to the valorization of the fruits, it is studied in this work, the behavior of bananas during each process. The determination of the physico-chemical parameters will make it possible to propose a step optimal and transposable of treatment of soft banana of variety *Musa sinensis*.

MATERIAL AND METHODS

Vegetable material

The bananas of the variety *Musa Sinensis* commonly called "sotoumon" were bought at the market of Godomey (Benin). This variety was selected for its abundance at the national level. The bananas were washed and soaked during 30 minutes in sodium an aqueous hypochlorite solution to 0.08 % of active chlorine, rinsed with running water then drained. They were then pulped and avoided (cut out) out of discs of 1 cm approximately thickness. The characteristics of sampled bananas were measured before any treatment.

- **Treatment of the fruits by dehydration impregnation by immersion (DII)**
- Two solutions were used for the DII. They are the binary solutions of water-saccharose (to 35°B and 50°B) and the ternary water-saccharose-NaCl solutions (of total concentrations: 52 and 55 g/100g of solution; respectively made up of 50/2 and 50/5 (p/p) of Saccharose/NaCl). The DII was carried out in glass pots of 800 ml to three various temperatures: ambient temperature (25-30°C), 45°C and 60°C. Ever since the stabilization of the fixed temperature, the bananas cuts were introduced into the solution according to a fruit/solution relation of 1/6 (m/m). The pots were agitated permanently using bar magnets placed at the bottom of each pot. The experiment was carried out during 0, 15, 60 and 180 minutes, with each one of them is associated a pot. The pots corresponding to the experimental times longest are furnished the first. At the end of the time assigned for each pot, the fruits were separated from the osmotic solution then drained in blotting papers before being dried. The transfers of matter which take place during the DII expressed in terms of water loss (PE), profit in aqueous solution (GS) were calculated starting from the equations suggested by Ehabe et *al*., (2006).
- The water loss at the moment t:
  $PE(t) = H(t_o) - [(M_p(t) / M_p(t_o)] \times H(t)$
- Profit of aqueous solution at the moment t:
  $GS(t) = PE(t) - RP(t)$

RP(t) : Weight loss at the moment t, relative with the initial mass of the product (g/g produces initial); and calculation as follows : $RP(t) = [M_p(t_o) - M_p(t)] / M_p(t_o)$
With Mp(t) **:** Sample weight at the moment t (g); H(t) **:** Moisture content of the sample at the moment t, relative to the initial weight of the product; t : Time (mn)

- **Thermal drying**

After dehydration, 100g of sample was spread out over plates then placed in the drying oven. The water loss of the product was recorded. The thermal operation of drying is stoped when the mass becomes constant (variation of 0.001 roughly between two weighing). Thermal drying by conversion with hot air was carried out at 45°C and 60°C in a ventilated drying oven of MEMMERT type with an air velocity of drying fixed at 1.5 m/s. Only banana samples presenting strong water losses after DII were dried. A control samples (sample not having undergone any treatment) were also dried.
The kinetics of water loss during the drying of the fresh and dehydrated banana samples were determined by their reduced expression and V (moisture content and fallback speed), starting from the following relations:

$\Phi = [X(t) - X_{éq}] / (Xo - Xéq)$ and $f(\Phi) = \Phi^n$

with :

- X(t), instantaneous moisture content of the product during drying
  $X(t) = [m(t) (1+X_o) / mo] - 1$ expressed as g.Water/g .MS
- m(t), instantaneous weight of the product during drying;
- m_0, weight of the fresh product to dry ;

- $X_{0,}$ the water content initial of the product on basis dries ;
  $Xo = (M_o - M_s) / M_s$
  $M_{0,}$ mass weighed fresh product before drying;
  $M_{S,}$ mass anhydrous of the fresh product after drying
- , balanced water content
  Xéq = $(M'_o - M'_s) / M'_s$
  $M'_{0,}$ mass weighed product dried before stoving;
  $M'_{S,}$ anhydrous mass of the product dried after stoving.

The speed of drying V, deduced from the instantaneous moisture contents from the products in the course of time from drying, is given by the following relation:

$V = - dX/dt$ expressed as (g Water / g MS) / hour

The fallback speed can be obtained by fixing a speed of reference $V_{réf}$, which one could regard as being the initial speed of drying, in the case of the biological products (Ahouannou *et al.,* 2010).

Characterization of the products after treatments

The pH, total acidity, Brix, the vitamin C content are given on aqueous suspensions of dried banana. The dried bananas were crushed and dissolved in distilled water (1: 5 m/m). The aqueous suspension was obtained after centrifugation at 10000tr/min during 20 min).

The pH wax obtained using a pH-meter of mark HANNA after calibration it with the buffer solutions of pH = 7 and pH = 4. For total acidity, a test specimen of 10 ml of the aqueous suspension is titrated with a NaOH centimolar solution until the turn of the indicator to the pink color, persisting during 10 s. the prevalent organic acid in banana being the malic acid, total acidity expressed as a percentage of malic acid.

Brix expresses the percentage of the soluble solids contained in a sample (an aqueous solution). The contents of the soluble solids represent the total of all the solids dissolved in water, including sugars, salts, proteins, the acids, etc. It was measured using a refractometer of the type ATAGO HSR-500.

The content of vitamin C is obtained by titration with iodine.

The water contents and the ashes contents were determined by the thermogravimetric method according to standard AOAC (1990).

- For the moisture content, it had been put in a tank out of aluminium initially weighed and tared weighed fruit of 10g with a margin of 0.001, the unit is carried to the drying oven during 72 hours with 103°C ± 2°C. After cooling in a desiccator, the dehydrated specimen test was weighed. One repeats the operations of heating, cooling and weighing but with successive stays in the 30 minute old drying oven each one, until the loss of mass between two successive weighings does not exceed 2 mg.
- For ash, 5 g of the sample were weighed in these crucibles and the unit is put in a furnace where they are heated gradually. After approximately 1h of heating to 250°C, the samples were heated in furnace at 550°C during 24h. The crucibles were then withdrawn then cooled in a desiccator until ambient temperature before being weighed. The percentage of total ashes was calculated on a raw samples basis. The ash content was determined by the gravimetric method by incinerating 5 g of banana treated or not in an electric furnace at 600°C during 3 hours.
- The color of the various types of bananas mixtures was measured using a colorimeter CR400 in the trichromatic system (L*, a* and b*) in accordance with the standards of the International Committee of Lighting (CIE; L* a* b*).

  With, L* = luminance or white index; a* = the redness or red index; b * = the yellowness or yellow index. For each sample of banana, six (06) repetitions were made.
- Texture was measured through the maximum force of shearing obtained on banana carrots using a texture analyzer LF *plus* (LLOYD *instruments*) provided with a triangular probe of shearing of Warner Bratzler type. The speed of lengthening of the machine applied was of 60mm/min. The maximum force was expressed in Newton. Six (06) repetitions were made by sample.

RESULTS AND DISCUSSION

The water Loss during osmotic dehydration

Figures 1 and 2 give the variations of the moisture losses (EP) of the products according to time. In the binary solutions at the end of the three (03) hours of treatment, the water losses reached respectively for the fruits treated in the solutions of 35 °Brix and 50 °Brix, 2 and 13.2 % at the ambient temperature; 12.6 and 21 % with 45 °C; 18.1

and 27.2% to 60 °C (Figure 1). As for the ternary solutions the water losses are 13.6 and 17.3 % at ambient temperature, 21.6 and 27.8 % with 45°C, and 31.8% and 33.4% with 60°C (Figure 2). It comes out from these figures that the water losses increase with the increase in the temperature and the concentration in aqueous solution. The most significant water losses in each case of aqueous solution, were obtained for bananas treated with 60°C in the saccharose solution of 50°Brix (27.2%) and for bananas treated with 60°C in the saccharose solution of 50°Brix with NaCl 5% (33.4 %). the significant influence of the temperature on the water loss was shown in previous work on mango, the apple (Sereno et *al*., 2001; Floury et *al*., 2008). Also, N'goran et *al*. (2012) showed that the increase in the concentration of the aqueous solution strongly contributed to the water loss of the fruit. This evolution could be due to a difference of the osmotic gradient between the fresh fruit (hypotonic) and the osmotic solution (hypertonic). In the case of the sweeten-salted solutions, the addition of NaCl increased to a significant degree the osmotic pressure between the fruit and the solution of immersion. Similar results were obtained by Alves et *al*. (2005) during the dehydration of the fruit acérola in the binary and ternary saccharose solutions of saccharose/NaCl. Indeed, several authors already showed that the presence of salt in the ternary solutions of saccharose/sel maintains a high level of water loss (Sereno et *al*., 2001; Collignan et *al*., 2001; Santchurn *et al*., 2007).

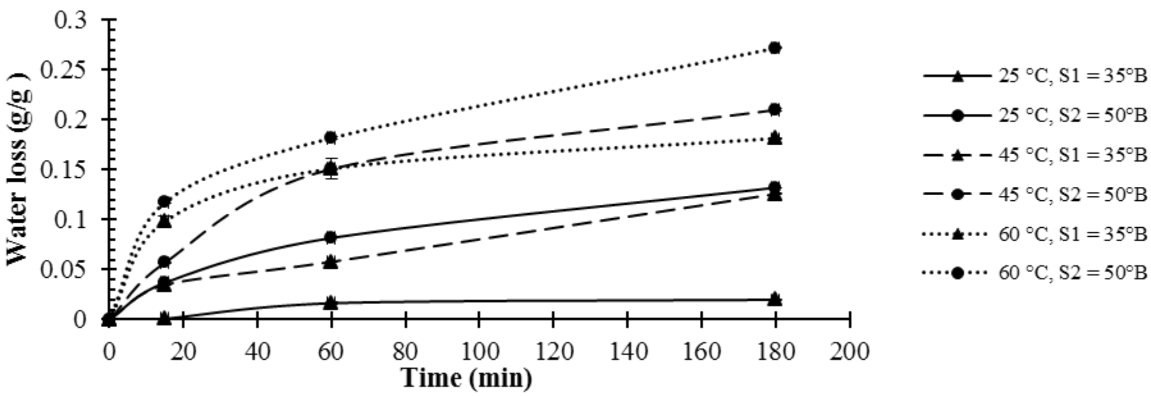

Figure 1: Evolution of the water losses of bananas treated in the saccharose solutions at various temperatures.

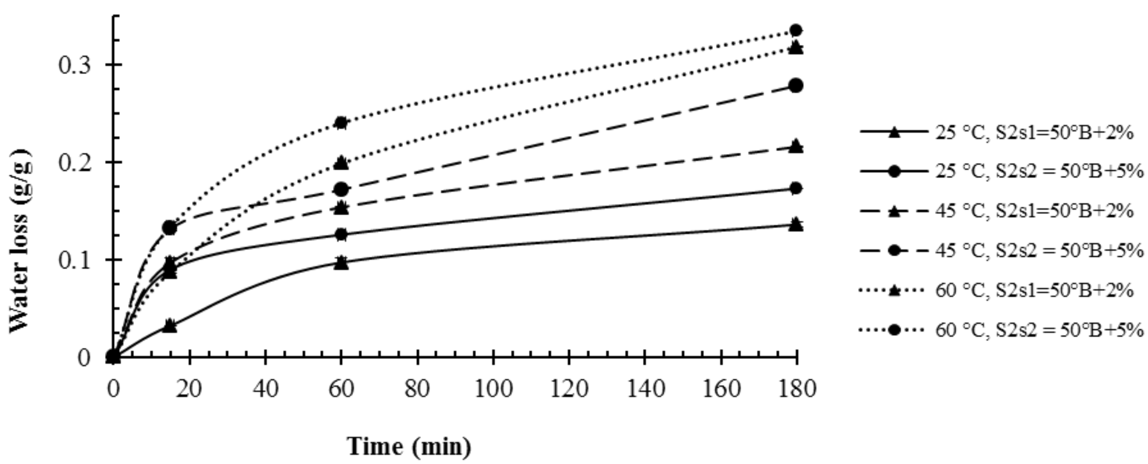

Figure 2: Evolution of the water losses of bananas treated in the ternary solutions of saccharose/NaCl.

Profit in aqueous solutions during osmotic dehydration

The profits in aqueous solution obtained after the treatment in the solutions water/saccharose give 0.9 and 1.8 % to ambient temperature, 1.2 and 2.5 % with 45°C then 0.5 and 4.1 % with 60°C, respectively for the fruits treated in the solutions of 35°Brix and 50°Brix. The profit of aqueous solution increases with the increase in the temperature and is higher for the fruits treated in the solutions of 50°Brix. The maximum profit of aqueous solution of 4.1%, was obtained in the current study for the fruits treated with 60°C in the solutions of saccharose of 50°Brix at the end of the three hours of treatment. Similar results were obtained by Pisalkar et *al*. (2011) during the dehydration of *Aloès*

vera in the solutions with 50 °Brix with 50°C and by Lee and Lim (2011) on pumpkin. The analysis of the variance revealed an increase in the profit in aqueous solution with the increase in conditions in treatment. However, for bananas treated with 60°C in the saccharose solutions with 35°Brix, we observes a reduction in the profit at the end of the treatment, that shows the limiting effect of the concentration. The effect of the temperature on the profit of aqueous solution is thus related to the concentration of the solution of immersion.
In the case of bananas treated in the ternary solutions of saccharose/NaCl (figure 4), the profits in aqueous solutions observed at ambient temperature are respectively 0.1 and 2.3 %, with 45 °C the profits are 1.3 and 2.1 %, then with 60°C, they are 4.4 and 6.2 %. The effect of the temperature and the concentration on the profit of aqueous solutions are the same one as that observe in the case of the binary solutions. However at the temperatures of 25°C and 45°C, the influence of the interaction between saccharose and salt (NaCl) on the transfer of aqueous solutions are strong and constitute a resistance to the transfer of aqueous solution. The maximum profit of aqueous solution obtained at the end of the three (03) hours of treatment is 6.2% for the fruits treated with 60°C in the ternary saccharose solutions of 50°Brix with NaCl 5%. That shows that to 60 °C, the influence of the interaction enters the aqueous solutions was not marked. Thus, Tonon et *al.* (2007) had observed that the strong temperatures reduce the viscosity of the solution and external resistance to the mass transfers. Similar results were also obtained on apple and the melon (Aminzadeh et *al.*, 2010; Sereno et *al.*, 2001). However, it would have to be recalled that it was noted that during the dehydration of mangos that the profit in aqueous solution varies in function according to the maturity of the treated product and conditions' of treatment applied.

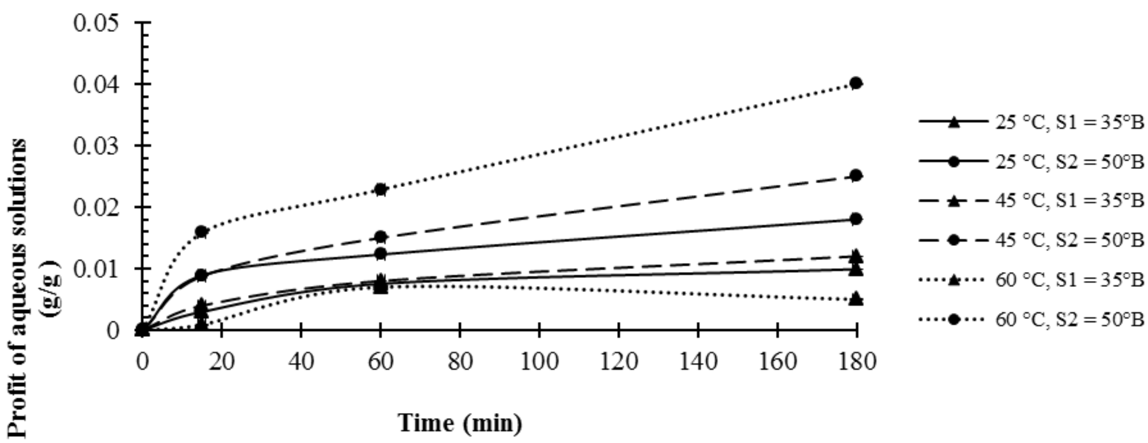

Figure 3: Evolution of the profits of aqueous solution of bananas treated in the saccharose solutions at various temperatures.

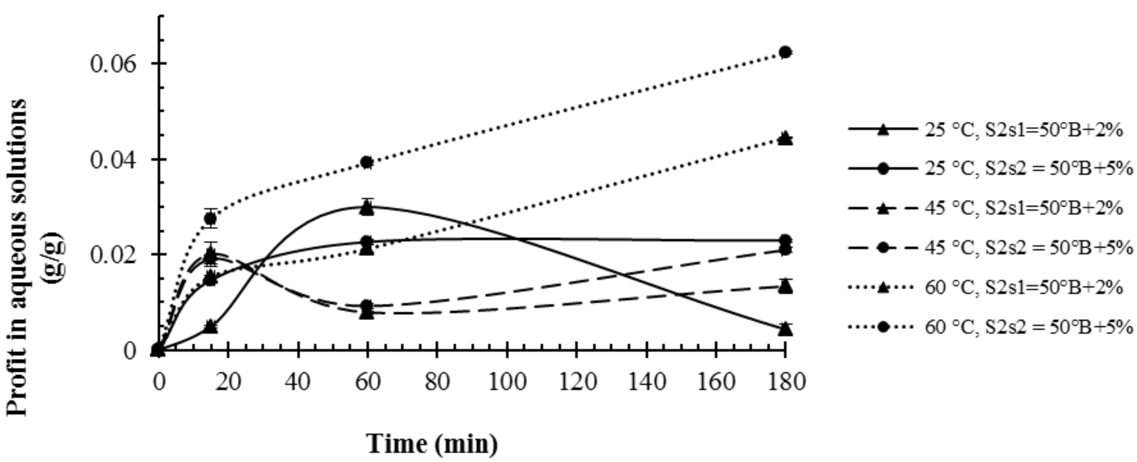

Figure 4: Evolution of the profits of aqueous solutions of bananas treated in the ternary solutions of saccharose and NaCl at various temperatures.

Considering the importance of the water losses observed for pretreated bananas in the binary saccharose solution with 50°Brix with 60°C, and the pretreated bananas in the ternary solution with saccharose 50°Brix plus 5% of NaCl salt to 60°C during three hours, these samples were retained for drying. Similar conditions of dehydration were retained by Alves et *al.* (2005).

Effect of the temperature and the treatment on the water loss of the dried banana samples

The curves of evolutions of the reduced water losses, speeds of drying make it possible to describe the water losses of the samples in the course of time.

The figure 5 give the evolutions of the reduced water losses (φ) according to time. The curves of thermal drying have a typical behavior observed in food with two principal distinct phases: a first phase during which the water content decreases quickly, at the time the first 24 hours of drying, followed by a phase of slower reduction until the end of drying. Treated with 45 °C, the averages water content of bananas decrease by 3.66 to 0.49 g water /g DM; from 2.51 to 0.54 g eau/g DM and of 1.62 to 0.4 g water /g DM respectively for the fresh fruits, pretreated bananas in the saccharose solution and pretreated bananas in the salt and saccharose solution. For the same samples treated with 60 °C, the values of the water contents vary respectively from 3.04 to 0.39 g water /g DMs; from 1.53 to 0.29 g water /g DM and of 1.50 to 0.26 g water /g DM. It comes out from these results that after drying with 45°C, the water content of pretreated bananas in the saccharose solution is slightly higher than the water content of pilot bananas. That can be explained by a difficulty of evaporation of water at the end of the drying due to the strong concentration of aqueous solutions to the periphery of the pretreated discs in the saccharose solutions. Ferradji et *al.* (2008), during the thermal drying of pretreated apples in the saccharose solutions with 60°Brix, showed the existence from a “layer barrier” with vaporization from water in the products charged in aqueous solutions. These results correspond well to those obtained by Silva et *al.* (2011) which reported that a long time of immersion or a treatment in a highly concentrated solution leads to the formation of a surface of barrier of aqueous solutions which blocks the exit of water as well during osmotic dehydration during thermal drying.

As for drying with 60°C, the curves of the water losses of bananas treated with 60°C marry practically the same pace. Thus, the analysis of the variance of the values of water loss reduced to 60°C did not show significant differences between the curves of water losses of the various samples.

All things considered, the final water contents average were all lower or equal to 0.55 g water/g DM for all the dried samples with 45 and 60°C. This water content is reached after 48 hours of thermal drying to 45°C and 16 hours of thermal drying to 60°C for the not-treated banana samples. For those treated in the saccharose solution with 50°Brix, it is reached after 53 hours of thermal drying to 45°C and 10 hours of thermal drying to 60°C. For the samples treated in the ternary solutions of saccharose (50°Brix) and NaCl (5%), the thermal time of drying which is 24 hours with 45° C decreases at 8 hours with 60° C. Thus, the water losses for each sample increase continuously with the increase in the temperature what entrained a reduction in the time of thermal drying. This reduction in the thermal time of drying with the increase in the thermal temperature of drying for banana was also observed by Talla et *al.* (2001).

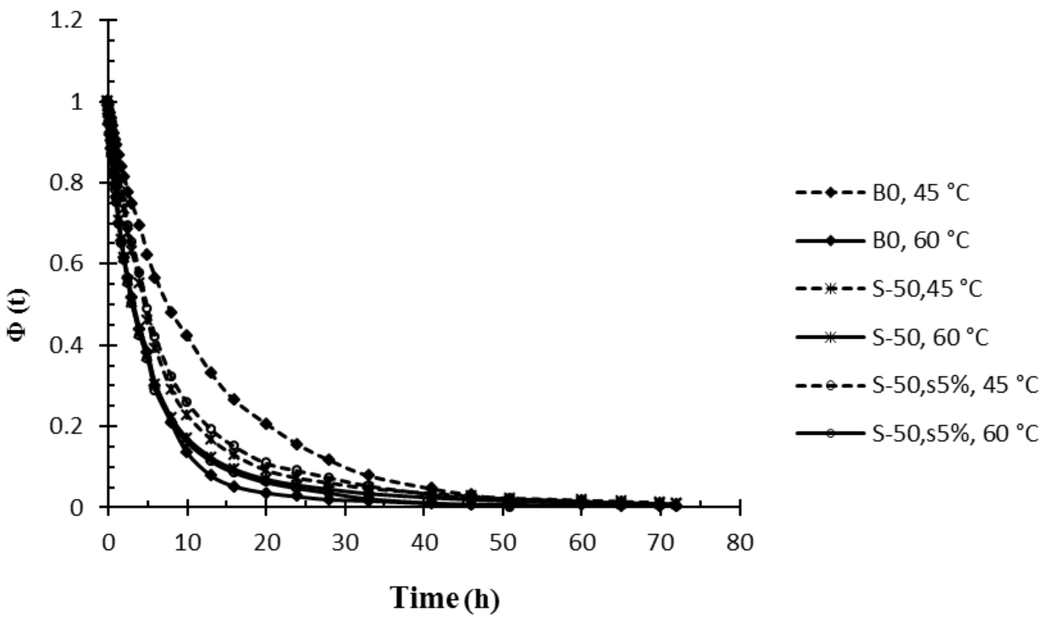

Figure 5: Variation of the reduced water loss of the banana samples fresh and dehydrated during drying.

Effet du traitement sur la vitesse de séchage

Figures 6 present the speed of thermal drying of the banana samples according to the water content at 45°C and 60°C. These figures show the evolution of the speed of drying in function of the time. Thus, during thermal drying with 45°C, speeds of drying vary from 0.49 to 0 g water/g DM.Hours $^{-1}$ for the control samples, 0.37 to 0 g water/g DM for the pretreated samples in the binary solution, from 0.24 to 0 g water/g DM.Hours $^{-1}$ for the pretreated samples in the ternary solution. At 60°C, maximum speeds are 1.1 g water/g DM.Hours $^{-1}$ for the control samples, 0.6 g water/g DM.Heures $^{-1}$ for the pretreated samples in the binary solution and 0.50 g water/g DM.Heures $^{-1}$ for the samples sweeten-salted. The speed of drying thus increases continuously with the increase in the temperature and the water content. It is controlled by the gradients of moisture which depend on the diffusion of water in the product. This effect of the temperature had been observed by Tallas et *al*. (2001) and Lagunas (2007) during their work on banana and garlic.

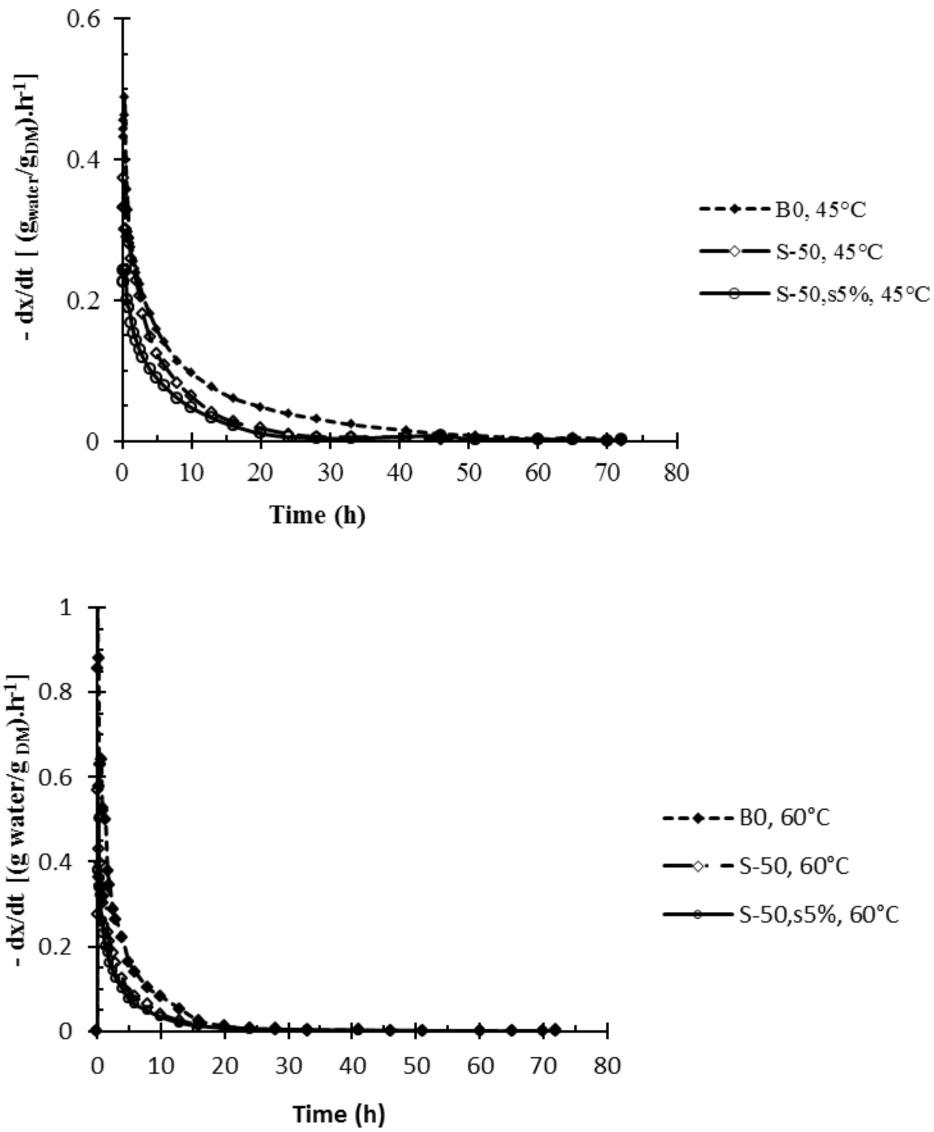

Figure 6: Evolution the speed of drying of the banana samples fresh and dehydrated in time

Physicochemical characteristics of the dried banana samples

Table 1 shows the physico-chemical characteristics of the banana samples. pH of dried bananas are acid and evolve from 4.6 to 4.7. As for acidity, it varies from 1.68 to 2.06%. The analysis of the variance revealed that there is not a significant difference between the pH of the various samples. On the other hand a difference is observed between the samples of treaties to 45°C and 60°C. Indeed the dried samples with 45°C seem more acid than those treated with 60°C. Similar results were obtained by certain authors during work on the thermal drying of mangos and the carrots (Kameni *et al*., 2003; Sra *et al*., 2011).
The values of Brix of dried bananas with 45°C vary from 62.5 with 70.5°Brix; while those dried with 60°C vary from 65.5 to 73 °Brix. These values very high in front of that of the banana fraiche (18.4°Brix) confirm the concentration of the aqueous solutions in the samples during treatments.
The proportioning of the content of vitamins C makes it possible to show that the bananas dried with post a light loss in vitamin C. Indeed, the content of vitamin C of 1.54mg/100g in the fraiche banana samples varies from 0.88 to

1.32 mg/100g in the treated samples. These results are similar to those obtained by Ndjouenkeu (2003) during its work on osmotic dehydration and the thermal drying of tomato. This loss in vitamin C was observed as well for the pretreated samples for the witnesses. Similarly, Kameni et *al*. (2003), during the thermal drying of mangos, reported that the oxidation of the vitamin C during thermal drying seems to be independent of the pretreatment undergone by the fresh product.

The ash contents of the various samples dried to 45°C and 60°C vary respectively from 1.12 to 5.11 % and from 1.59 to 5.9%. The analysis of the variance showed as the ash contents vary as well according to the treatment undergone by the fresh samples as of the thermal temperature of drying. The strongest values of ashes were recorded for bananas dehydrated in the sweeten-salted solutions. The bananas dehydrated in the saccharose solutions post a light loss of ashes because of the diffusion of minerals observed as a preliminary during dehydration for these fruits. The minerals thus are concentrated in the samples dried than in the fresh products. This concentration of minerals increases with the increase in the thermal temperature of drying and is higher in the case of bananas dehydrated with the ternary solution of saccharose and cooking salt. The presence of salt also contributes to the increase in the ash content.

The luminance, the redness and the yellowness, as well as the texture vary according to the treatment undergone by the banana sample. After thermal drying, the bananas loss of their luminance to compare with the raw banana. Indeed, the raw banana with a luminance of 72.8; an index of red almost null (0.12) and an index of yellow of 29.9. For the samples treated with 45°C luminance varies between 52.65 and 60.22 whereas it varies from 37.24 to 55.81 for the sample treated at 60°C. The indices of red of the dried samples vary from 6.40 to 14.28 while the indices of yellow vary from 21.84 to 39.71. It comes out from these results that the samples sweeten-salted before drying have the highest values of luminance and index of yellow while the index of red is higher in the sample of sweetened samples. This change of color of the dried product is allotted to the combination of the enzymatic tanning, non-enzymatic and also with reactions of caramelization. The bananas without pretreatment and those pretreated in the brown sugar as thermal drying is prolonged and that the temperature increases (Karmas et al., 1992).

The same observations were made by Lagunas (2007) which reported that these reactions are supported by the prolonged exposure of the product to high temperatures. However, these variations of colors observed for the witnesses are not also significant for the pretreated bananas which give a more attractive aspect. The bananas treated in the saccharose solution are characterized by the index of brightness to the high red. That is due to the incorporation of sugar by these fruits which caramelizes during the thermal drying. The pretreated bananas in the sweeten-salted solution have colors little marked during thermal drying. This maintenance of the color observed in the case of pretreated bananas in the salt and sugar solution would be allotted to the incorporation of NaCl.

The shear forces vary from 55.53 to 133.90 N for the pretreated samples. These forces make more than 9 to 22 times the force necessary for the shearing of the banana fraiche (6.1N). It however arises from the results that the force of shearing increases with the temperature and the pretreatment. These results confirm those obtained on the apple and banana samples (Ehabe *et al*., 2006; Ferradji *et al*., 2008).

Tableau 1: Physico-chemical characteristics of dried bananas

.

Thermal temperature of drying	Samples	pH	Total acidity (%)	Brix (%)	Vitamine C (mg/100g)	Ashes (%)	Water content (%)	L*	a*	b*	Force (Newton)
45°C	**Pilot bananas**	**4 .6±0.01^{a}**	**2.06±0.2^{a}**	**70.5±3.0^{a}**	**0.88±0.06^{a}**	**2.43±0.0^{a}**	**32.89±1.5^{a}**	**56.55± 2.65^{ab}**	**7.17± 0.64^{a}**	**27.02± 0.90^{a}**	**62.14± 3.03^{a}**
	Pretreated bananas in a saccharose solution with 50°Brix	**4.6±0.01^{a}**	**1.94±0.1^{b}**	**62.5±2.0^{b}**	**1.12±0.03^{b}**	**1.12±0.0^{b}**	**35.6±0.9^{b}**	**52.65± 0.81^{b}**	**9.16± 0.41^{b}**	**36.62±0.17^{b}**	**55.53± 2.09^{a}**
	Pretreated bananas in a solution with 50°Brix +5% of salt	**4.6±0.07^{a}**	**2.04±0.1^{a}**	**64.5±0.7^{c}**	**1.19±0.05^{b}**	**5.11±0.0^{c}**	**29.57±1.2^{c}**	**60.22± 0.74^{a}**	**6.40± 0.57^{a}**	**39.71± 0.77^{c}**	**79.09± 4.59^{b}**
60°C	**Pilot bananas**	**4.7±0.01^{a}**	**1.83±0.1^{a}**	**73±001^{a}**	**1.12±0.09^{a}**	**2.53±0.0^{a}**	**28.05±2.0^{a}**	**37.24± 1.05^{a}**	**11.95±0.10^{a}**	**21.84± 0.6 ^{a}**	**131.50± 5.45^{a}**
	Pretreated bananas in a saccharose solution with 50°Brix	**4.7±0.01^{a}**	**1.85±0.1^{a}**	**65.5±3.3^{b}**	**1.32±0.06^{a}**	**1.59±0.0^{b}**	**23.07±2.4^{b}**	**48.76± 2.48^{b}**	**14.28± 0.61^{b}**	**30.72± 0.64^{b}**	**133.90± 5.57^{a}**
	Pretreated bananas in a solution with 50°Brix +5 % of salt	**4.6±0.07^{a}**	**1.86±0.1^{a}**	**66.6±4.2^{c}**	**1.34±0.03^{a}**	**5.90±0.0^{c}**	**20.63±1.6^{c}**	**55.81± 1.39^{c}**	**10.73± 0.53^{c}**	**33.16± 0.65^{c}**	**114.80± 3.80^{b}**
	Bananas fraiche	**4.7±0.20^{a}**	**1.68±0.3^{ab}**	**18.4±2.1^{d}**	**1.54±0.37^{a}**	**0.86±0.03^{d}**	**75.52±1.37 d**	**72.8±0.43**	**0.12±0.04**	**29.9±0.95**	**6.1±0.48**

Les moyennes interclasse de la même ligne suivies de lettres différentes diffèrent significativement au seuil de 5%.

CONCLUSION

The combination of osmotic dehydration and drying ensure the preservation of the fruits by reduction of the moisture but influence the physico-chemical characteristics of bananas. The osmotic dehydration of bananas in the solutions sweetened (50°brix) and sweeten-salted (50°brix+ 5% of salt) help to reduce the initial water content of 30%. Moreover, this pretreatment made it possible to reduce the time of drying to 10 or 8 hours according to whether drying is carried out to 45 or 60°C.

At the end of the drying, it arises from the results obtained that pH, and acidity vary very little. These results show also a concentration of the aqueous solutions with the increase in the brix and the ash content of bananas. The pretreatment by osmotic dehydration also reduce the loss of the vitamin C and the tanning of bananas during drying. The treatment by osmotic dehydration and the drying of banana made it possible to better preserve its physico-chemical characteristics while reducing the moisture content, the main factor of degradation.

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