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Postharvest Treatment of Tropical Fruits Pineapple (*Ananas comosus*), Mamey (*Mammea americana*), and Banana (*Musa paradisiaca*) by Means of a Solar Dryer Designed

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Abstract

The objective of this research was to know the useful life of dehydrated tropical fruits based on a solar dryer designed and developed under the conditions of Calceta, Bolívar Canton of the Province of Manabí, Ecuador. The physical and chemical characteristics exhibited during the radiation dehydration process were satisfactory, in fresh pineapple from 86.36% low humidity to 21.07%, from 0.67% protein to 2.45%, and from 2.05% fiber to 3.73%; in mamey from 79.30 to 21.07%, from 0.41 to 2.55%, and from 2.50 to 4.94%; and in bananas with from 80.22 to 10.35%, from 1.27 to 2.14%, and from 0.88 to 2.42. Microbiological analyses determined the life span of the products estimated at 174, 106, and 109 days, respectively, in pineapple, mamey, and banana. As for the attributes measured with the 1–5 scale of sensory evaluation, the mean treatments of their attributes such as color, sweetness, appearance, and taste were demonstrated where bananas present better color attributes with 4.38; 4.58, sweetness; 4.58, texture;4.68, appearance; and 4.75, flavor. Where significant diffraction can be determined relative to the calculated value p > 0.05 of <0.0001, the R^2 statistic in pineapple indicates 48.0814% variability in decreasing moisture pineapple (DMP), and its correlation coefficient is equal to 0.693408; the R^2 statistic in mamey indicates 55.6423% variability in decreasing moisture mamey (DMM), and its correlation coefficient is equal to 0.745938; and finally the R^2 statistic in banana indicates 56.339% variability in decreasing moisture banana (DMB), and its correlation coefficient is equal to 0.750593, indicating a moderately strong relationship between variables in all cases.

1. Introduction

In the Bolivar Canton of the city of Calceta of the Province of Manabí, Ecuador, the fruits pineapple (*Ananas comosus* (L.) Merr.), mamey (*Mammea americana* L.), and banana (*Musa paradisiaca* L.) are exuberant but due to high sugar and acid content have a limited shelf life and in many cases are wasted. Also, because these characteristics are easily adapted to conservation technologies, one of them is fundamentally dehydrated since they retain much of their taste, color, consistency, and appearance for long periods (see [1, 2]).

Sunlight from before and so far today serves to perform fruit drying as postharvest handling or conservation activity that, when purchased with other activities for the same purpose, such as chemical treatments, refrigeration, canned pre-eminence with operation, and collection even with solar drying, results in a decrease in energy expenditure spending and could therefore reach areas where other energy conveniences would not or even do not exist (see [3]).

In fruits the water present is 80.00% of its weight, for its early microbial decomposition is a definitive element. A conventional dehydrated fruit of its quality in terms of its organoleptic characteristics is lower than that of the fresh fruits from which it comes, affecting color, texture, and other peculiarities. With hot air, dehydrated fruits acquire levels of water activity (a_w) ranging from 0.6 to 0.8; these levels retain their sensory properties, showing good firmness to microbial attacks (see [4]).

Convective multiflash drying (CMFD) is a matter that is obtained after being used to obtain crispy fruits, and it is an option to the freeze-drying process (see [5]).

The industrial-scale study, a simple convective solar drying process of pineapples such as a round or circular economy tactic for countries in progress is specified, which is paramount to the tactic offered. It built a manual solar dryer that runs in indirect heat mode; it was also changed to improve its gain. The three main elements were raised that affect the convective drying process, the drying time (270 min, 480 min), the intensity of the solar radiation (650 W•m^{-21}, 100 W•m^{-2}), and the thickness of the cut (6–8 mm, 12–14 mm) (see [6]).

According to these instances, the aim of the research was to design and develop an empirical and practical distribution for solar dryer and drying tests to conserve the fruits and extend the shelf life, as well as organoleptic and nutritional particularities with samples of pineapple, mamey, and banana fruits in the city of Calceta, Bolívar Canton of the Province of Manabí, Ecuador.

2. Climate data collection

The research work was carried out from February to April 2013, in the school avenue of Calceta, Bolívar Canton, Province of Manabí, Ecuador, on the consecutive lines: South latitude 00′34.22′, west latitude 80 or 10′09.2′, average altitude of 22 masl, with a relative humidity of 90.00%, a temperature of 32.8°C, and a wind speed of 8 m.s^{-1}, until the end of November; the respective humidity is 86.7%, the temperature is 26°C, and the speed 1.8 m.s^{-1} (see [7]).

3. Design and construction of solar dryer

A dryer is used in heating the air by a 1 mm solar flat panel, insulated drying chamber equipped with stove where air is released for exhaust purposes. **Figure 1** describes the landscape of empirical or experimental distribution. The rustic surface of the solar collector is 0.5 × 0.5 × 1 m with a height of 0.7 m. The solar air heater is based on a folded suction plate with a dark bluish-look dyed uve (V) representation wood, as regards the exclusion of corresponding spaces on the sides as well as on the upper; the glass sheet was sealed with silicone-based material, diagonal to 15o, towards a dorsal part of the receiver (collector); a perforation was worked to carry out ventilation activities in the manner of air currents in other instances the side part, a lami was located a lami na (FV) photovoltaic to be able to understand the photoelectric effects that come from solar radiation, so with the receiver (collector) to dehydrate the fruits were stained bone white in all its accesses, covered with aluminum plate; the entrance had five ships distributed at a distance of 15 cm between each of them. The container was made of an aluminum-based wire mesh and glued to the frame inside the drying chamber. The collector outlet air enters the drying chamber at the bottom, immediately flowing into the upward orientation using the drying material. The camera was insulated from all sides except the top, the camera was tested with a fireplace for exhaust air, and the height of the fireplace was 0.25 m. These are the aspects that contemplate the construction of the solar dehydrator for the fruits (see [7]) (**Figures 2** and **3**).

3.1 System dimensioning

3.1.1 Collector area calculation

Busy strip (1.8 × 1.0) m. 1.80 m^2; Global radiation on average per day 1353 W•m^{-2}. Lots of temporary global units of solar radiation were calculated by manipulating a solar energy meter (Tenmar TM 207) with an accuracy of
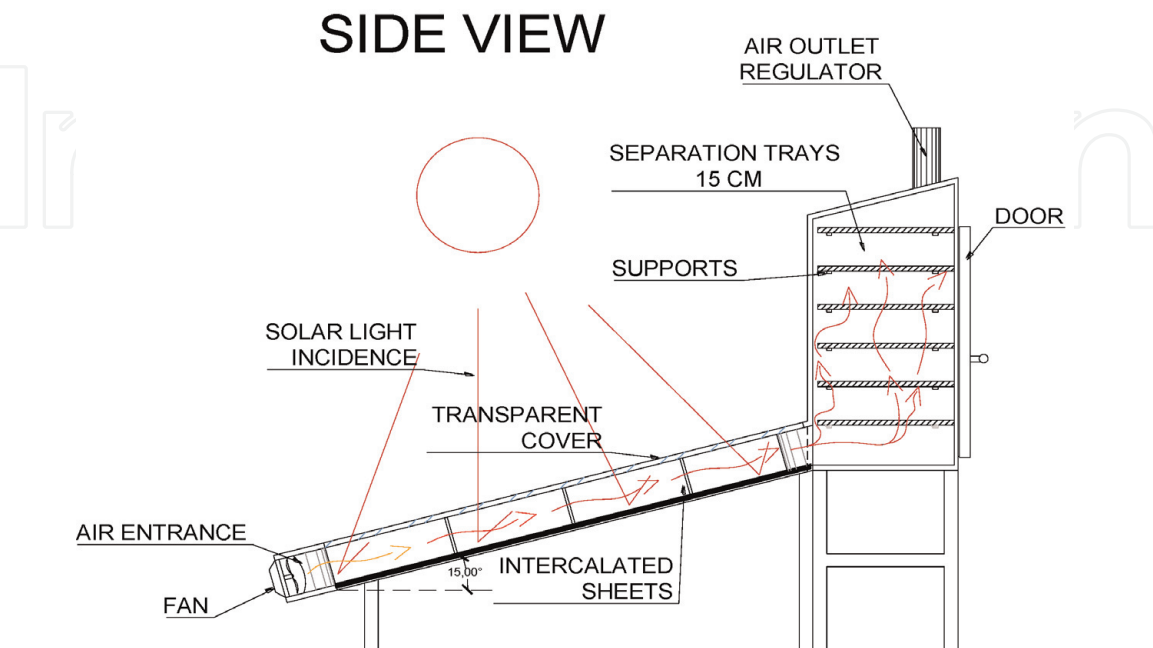

Figure 1.
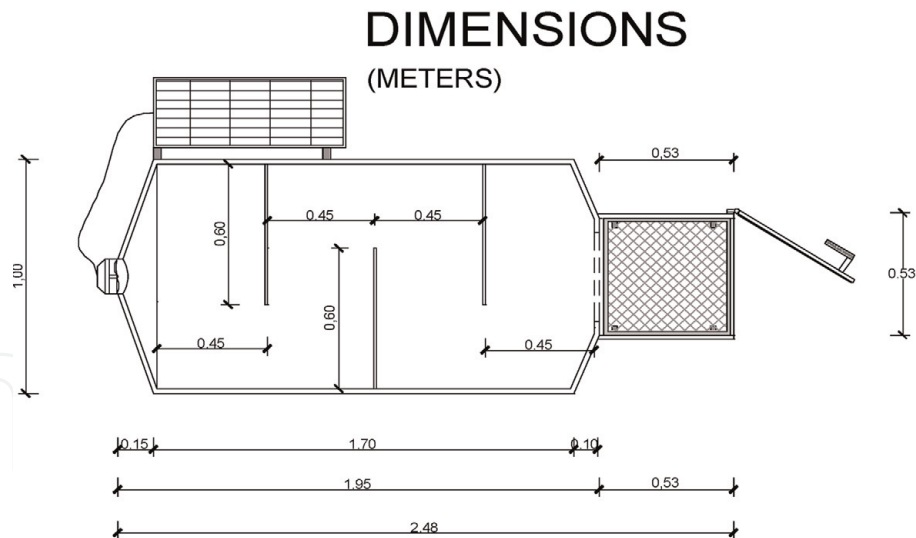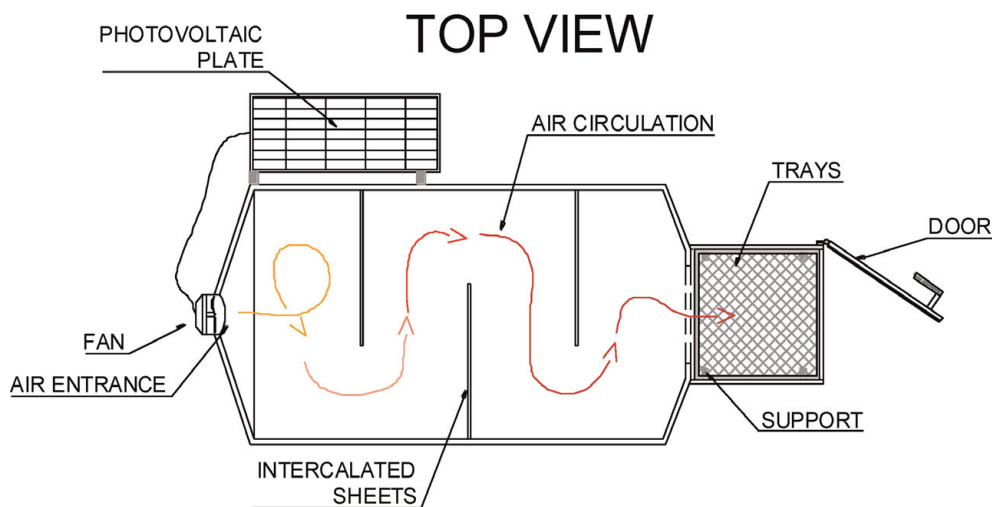*Schematic view of experimental setup with solar flat plate collector.*

Figure 2.
End-floor view.

Figure 3.
Pair heating spray for process.

10 W•m^{-2}. Temperature readings were recognized every hour from 8:00 am to 6:00 pm. RTD were established at the inlet and outlet of the collector (Tin, Tout), outdoors to calculate the ambient temperature (Tamb) (see [8]).

3.1.2 Drying chamber

The volume of the drying chamber was established (oven example cabinet); consecutively, the average density of the fruits to be dried was 200 Kg.m^{-3}, with a mass of 4 kg; 4/200 to 0.02 m^3, being ten times more, a value close to 0 was obtained, 20 m^3.

3.1.3 Sterilization procedure

The matter is formed with preparations such as tools and components which I discuss the following:

The tools handled in the test consisted of sterilization at 180°C for 60 min according to the Medical Research Council; the chopping of the fruits was done in a sterilized part in advance rinsed with neutral soap; to quickly immerse the fruits in water with $C_6H_8O_6$ ascorbic acid to prevent oxidation and then fit into the dryer, start the test by placing the dehydrator; feel this part of the dryer, facing north, so that the collector takes the sun rays east to west. Three repetitions are executed for each fruit which are delayed from 3 to 5 days for each repetition. At the end of each day, the samples are wrapped in foil and sealed tightly and stored.

3.1.4 Statistical analysis of the values by treatments

Statistical analysis was contemplated with a complete or random design with therapizations in each of the treatments; the units are practices or experimental comprising of 4 kg of dried fruit. These results are tabulated making use of Statgraphics software and InfoStat™ 5.1TM in terms of linear regression and variance (ANOVA). To identify significant differences in treatments, as well as statistical significance for all comparisons, $p < 0.05$ was used. The Tukey multirange test was used to compare mean values of treatments.

4. Results

4.1 Bromatological analysis of fruits evaluated

At the bromatology laboratories of the Agricultural Polytechnic School in Manabí Manuel Félix López (ESPAM MFL) and CE.SE. C.CA Unibersidad Laica Eloy Alfaro de Manabí (ULEAM), Manta, Ecuador, analysis of moisture, ash, proteins and fiber is conducted, and 250 g was manipulated for each sample, published in **Table 1**.

The percentage of humidity in pineapple decreased from 86.36 to 21.14%, in mamey from 79.30 to 21.07%, and banana from 80.22 to 10.35%; ashes amount in pineapple from 0.44 to 1.09%; in mamey from 0.25 to 2.66%, and in bananas from 1.12 to 2.80% indicating that in the latter, it is higher than the previous fruits.

For pineapple protein amounts from 0.67 to 2.45%; for mamey from 0.41 to 2.55%, and for banana from 1.27 to 2.14%; in this case the three fruits increased their amounts, and finally the amount of fiber in pineapple is from 2.05 to 3.63%, in

Fruit state	Parameters	Method	Unity	Pineapple	Mamey	Banana
Fresh fruit	Moisture	INEN 864	%	86.36	79.30	80.22
	Ash	INEN 467	%	0.44	0.25	1.12
	protein	PEE/SECECCA/QC/15	%	0.67	0.41	1.27
	Fiber	PEE/SECECCA/QC/03	%	2.05	2.50	0.88
Dehydrated fruit	Moisture	INEN 864	%	21.14	21.07	10.35
	Ash	INEN 467	%	1.09	2.66	2.80
	protein	PEE/SECECCA/QC/15	%	2.45	2.55	2.14
	Fiber	PEE/SECECCA/QC/03	%	3.63	4.94	2.42

Table 1.
Bromatological analysis on fresh and dehydrated fruits.

mamey from 2.50 to 4.94%, and in banana from 0.88 to 2.42% of the same way augments, respectively.

4.2 System efficiency in each of the fruits

Figure 4 and **Table 2** show the moisture extracted against the emission of the radiation; according to this we manage to determine that the molecular structure of the banana facilitates the extraction more accelerated or rapidly with respect to moisture, thus following the pineapple and mamey in which it can be proven that the equipment is more efficient for banana fruit.
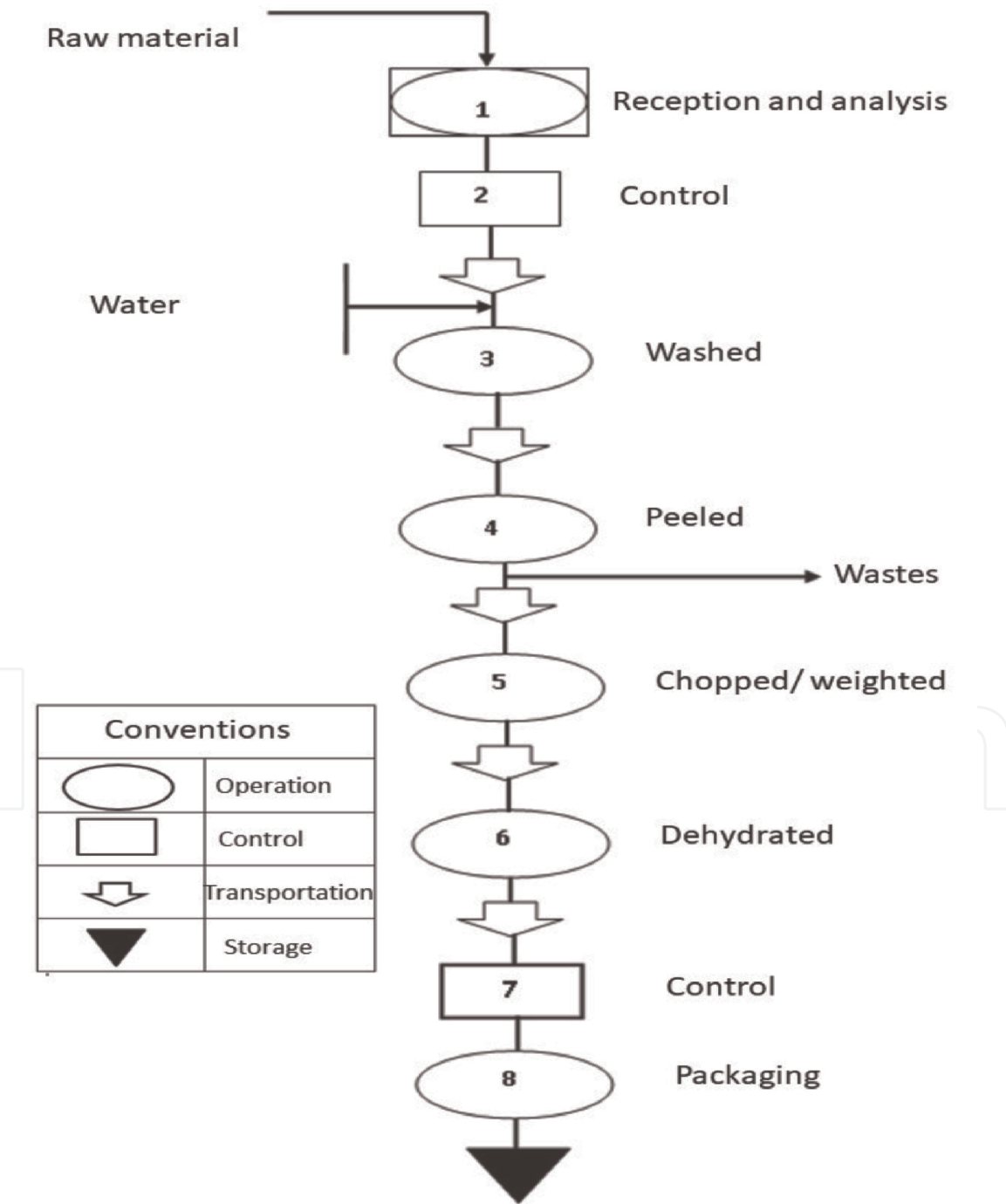

Figure 4.
Process flow chart of dried pineapple, mamey, and banana fruits.

Solar radiation (W • m^{-2})	Pineapple (% H)	Mamey (% H)	Banana (% H)
300	45.61883	46.54318	8.205
350	53.41883	50.89206	27.606
400	61.21883	55.24094	47.007
450	69.01883	59.58982	66.408
500	76.81883	63.9387	85.809
550	84.61883	68.28758	105.21
600	92.41883	72.63646	124.611
650	100.21883	76.98534	144.012
700	108.01883	81.33422	163.413
750	115.81883	85.6831	182.814
800	123.61883	90.03198	202.215
850	131.41883	94.38086	221.616
900	139.21883	98.72974	241.017

Table 2.
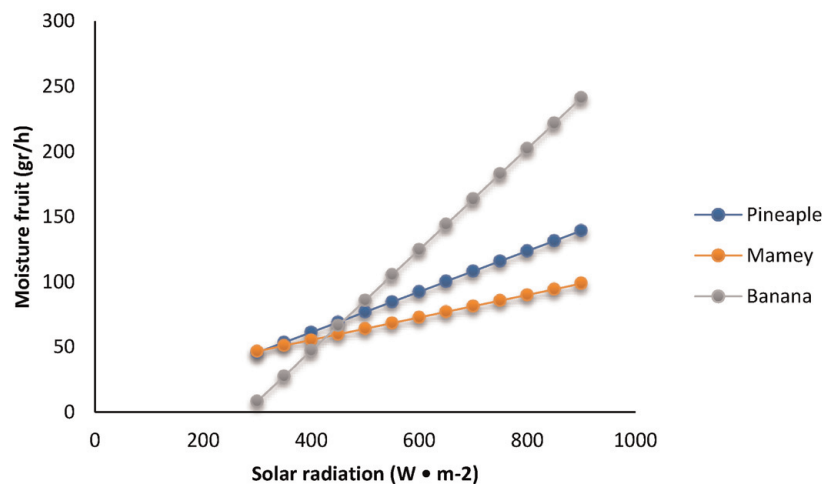*System efficiencies vs. dehydrated fruits.*

Figure 5.
Differentiation of water vapor contents as absolute humidity according to solar radiation.

Figure 5 shows the moisture variation as a function of solar radiation in the evaluated fruits, pineapple, mamey, and banana, respectively.

4.3 Microorganism tests to learn about fruit shelf life

In a given time of 15 and 30 days for the purpose of concerning the fruit drying activities assessed, each repetition is presented with their respective microbiological examinations with units of measurement in CFU.g^{-1} which in turn were compared with Ecuadorian Standardization Service (INEN) standards with their details in maximum limits allowed; in other instances the microorganisms found in the samples requested from the microbiology laboratories of the Agricultural Polytechnic School of Manabí Manuel Félix López (ESPAM MFL) are multiplied exponentially, of mathematical type making use of exponents, i.e., the fickle x (unit of measure (d)) suppressed day presents the lifetime data for which the following are assessed: pineapple 174, mamey 106, and banana 109 (**Figure 6**).
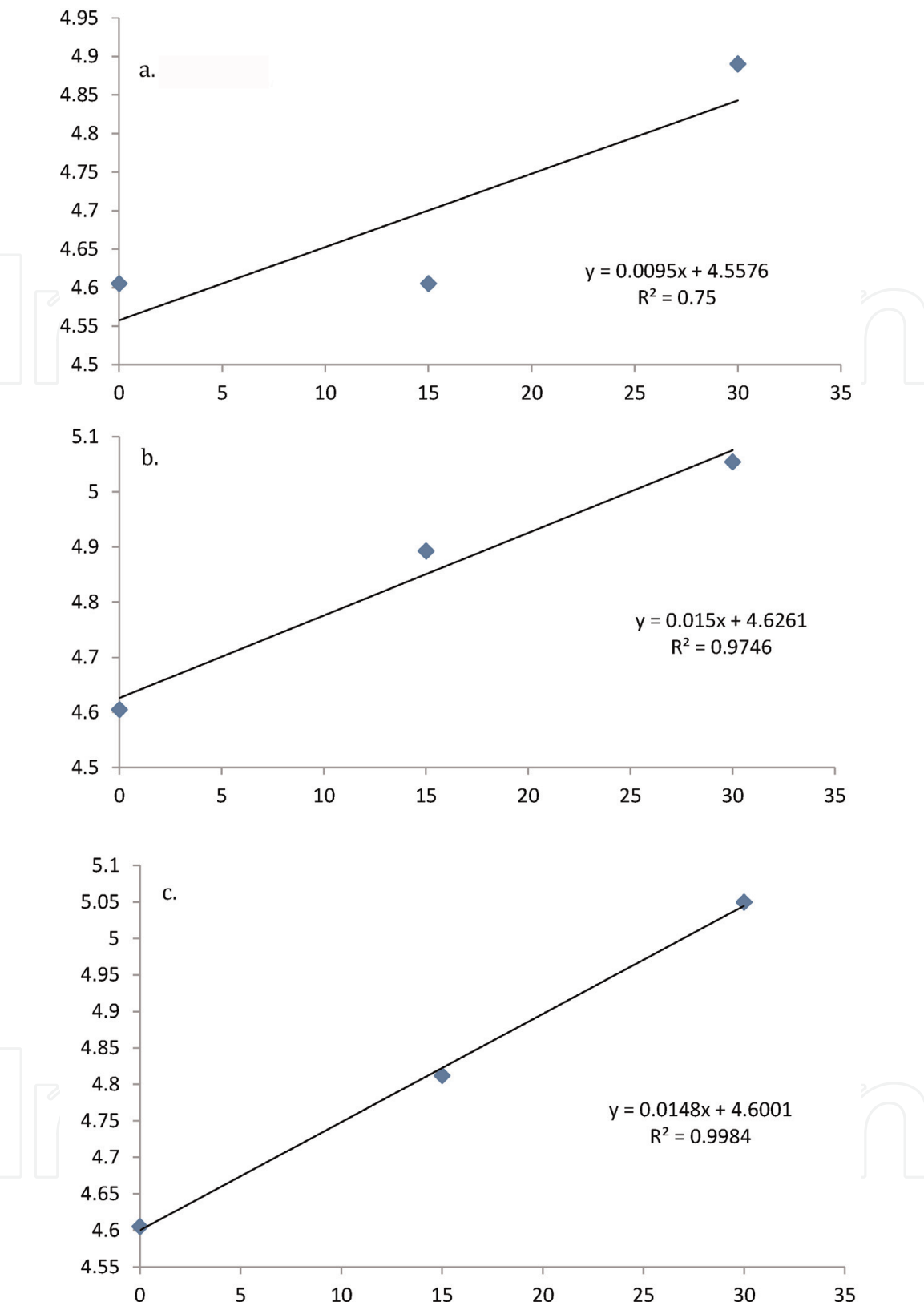
Figure 6.
Shelf life for dehydrated fruits. (a) Pineapple; (b) mamey; (c) banana.

4.4 Sensory evaluation with scale 1–5

The attributes evaluated were texture, sweetness, aspect, color, and flavor; these were calculated on the basis of the InfoStat software, allowing the most relevant characteristics of the attributes to be in their respective order for dehydrated fruits of pineapple, mamey, and banana, respectively (**Figures** 7 and **8**, **Tables 3–5**).
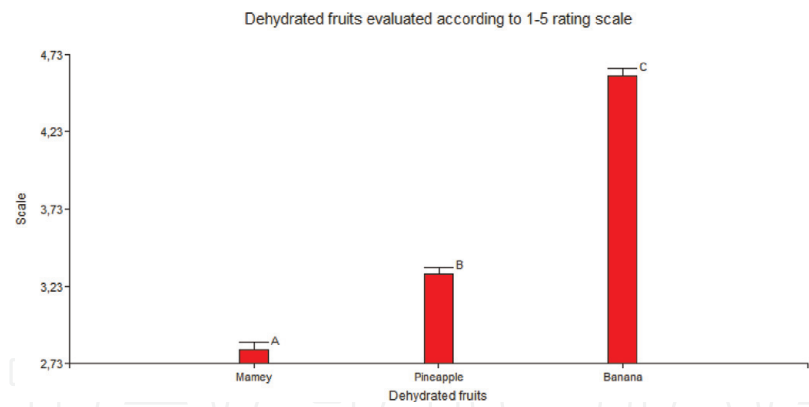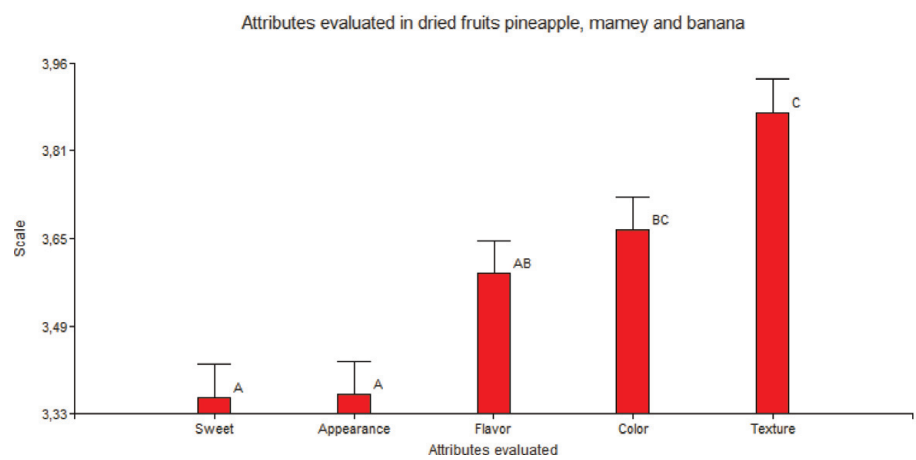
Figure 7.
The valuation scale in dehydrated fruits.

Figure 8.
Evaluation of dehydrated fruit acrations depending on the scale score.

Variable	N	R^2	R^2Aj	CV
Scale	300	0.76	0.75	12.87

Table 3.
Analysis of variance.

F.V.	SC	gl	CM	F	p-value
Model	193.09	14	13.79	65.32	<0.0001
Factor A	168.56	2	84.28	399.17	<0.0001
Factor B	11.12	4	2.78	13.16	<0.0001
Factor A*Factor B	13.42	8	1.68	7.94	<0.0001
Error	60.17	285	0.21		
Total	253.27	299			

Table 4.
Variance analysis (SC type I).

9

Factor A	Factor B	Half	n	E.E.					
error: 0.2111 gl: 285									
Mamey	Sweet	2.48	20	0.10	A				
Mamey	Appearance	2.51	20	0.10	A				
Mamey	Flavor	2.53	20	0.10	A				
Pineapple	Appearance	2.91	20	0.10	A	B			
Pineapple	Sweet	3.03	20	0.10		B	C		
Mamey	Color	3.21	20	0.10		B	C	D	
Mamey	Texture	3.35	20	0.10		B	C	D	
Pineapple	Color	3.40	20	0.10		B	C	D	
Pineapple	Flavor	3.48	20	0.10			C	D	
Pineapple	Texture	3.70	20	0.10				D	
Banana	Color	4.38	20	0.10					E
Banana	Sweet	4.58	20	0.10					E
Banana	Texture	4.58	20	0.10					E
Banana	Appearance	4.68	20	0.10					E
Banana	Flavor	4.75	20	0.10					E

Means with a common letter are not significantly different (p > 0.05).

Table 5.
Test: Tukey Alpha = 0.05 DMS = 0.49402.

4.5 Relationship and recoil tests concerning the access temperature in dryer with the receiver access sheet (collector), as well as the radiation with the low amounts of water as absolute humidity in the fruits of pineapple, mamey, and banana

Based on p-value in ANOVA calculated less than 0.01, therefore, there is a significant relationship from the statistical level, between the drying T°C and the plate T°C with 99% confidence level.

R^2 indicates the percentage (%) variation of the response variable that explains its relationship to one or more predictor variables; it can be said that the higher the R^2, the better the arrangement of the model to the obtained data.

So according to this premise, the model exposes 61.3763% variability in drying T°C, and the correlation coefficient is equal to 0.78343; therefore, it indicates a moderately strong relationship between the variables, and the standard error evaluation shows in the calculation that the standard deviation of the residuals is 2.51359.

Regression exam/linear pattern $Y = a + b * x$.

Dependent variable (VD): drying T°C

Independent variable (VI): plate T°C

The results expose the output, and it conforms to the linear model to refer to the relationship between the drying T°C with the plate T°C.

The equation of the adjusted model below is

$$Drying\ T°C = 20.0773 + 0.275953 * plate\ T°C \tag{1}$$

4.5.1 Regression examination between drying temperature and receiver temperature (collector)

Depending on p-value in ANOVA less than 0.01, therefore, there is a significant statistical relationship between the drying T°C and the T°C of the collector with a level of 99% confidence.

R^2 indicates that the model exposes 59.672% variability in drying T°C, and the correlation coefficient is equal to 0.772477, therefore indicating a moderately strong relationship between the variables (**Figure 9**).

Regression exam/linear pattern $Y = a + b * x$

Dependent variable (VD): drying T°C

Independent variable (VI): collector T°C

The results expose the output, and it conforms to the linear model to refer to the relationship between the drying TOC and the collector TOC.

The equation of the adjusted model below is

$$Drying\ T°C = 23.2088 + 0.269216 * Collector\ T°C \tag{2}$$

4.5.2 Pineapple fruit and your regression exam

Depending on p-value in the ANOVA less than 0.01, there is a significant statistical relationship between DMP and SRP with a 99% level of trust.

R^2 indicates that the model exposes 48.0814% variability in DMP. The correlation coefficient is equal to 0.693408; therefore, it indicates a moderately strong relationship between the variables, and the standard error evaluation of the sample in the calculation shows that the standard deviation of the residuals is 23.4888 (**Figure 9a**).

Linear pattern $Y = a + b * x$

Dependent variable (VD): decreasing moisture pineapple (DMP)

Independent variable (VI): solar radiation pineapple (SRP)

The effects of linear model adjustment refer to the relationship between DMP and SRP.

The equation of the adjusted model below is
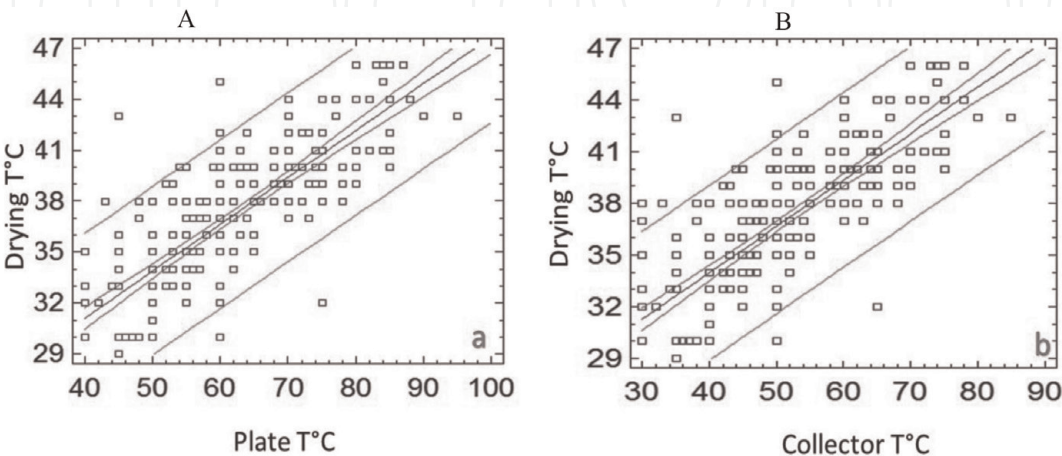
$$DMP = -1.18117 + 0.156 * SRP \tag{3}$$

Figure 9.
Drying inlet with plate temperature (a) and receiver temperature (collector) (b), where the adjusted model is displayed.

4.5.3 Mamey fruit and your regression analysis exam

Depending on the p-value in ANOVA calculation which is less than 0.01, there is a significant statistical relationship between DMM and SRM with a confidence level of 99%. The R^2 states according to model that there is 55.6423% variability in DMM, the correlation coefficient is equal to 0.745938; therefore, it shows a moderately dynamic relationship between the variables, and the standard error evaluation shows that the standard deviation of the residuals is 12.3989 (**Figure 9b**), as well as the average absolute error (AAE) of 10.7287.

Linear pattern $Y = a + b*x$

Dependent variable (VD): decreasing moisture mamey (DMM)

Independent variable (VI): solar radiation mamey (SRM)

The effects of linear pattern adjustment to refer to the dependency between DMM and SRM.

The equation of the adjusted model below is

$$DMM = 20.4499 + 0.0869776 * SRM \qquad (4)$$

4.5.4 Banana fruit and your regression analysis exam

Based on ANOVA's p-value in calculation less than 0.01, there is a significant statistical ratio of DMB to SRB with a confidence level of 99%, while R^2 exposes according to model that there is 56.339% variability in DMB; in other instances the correlation coefficient the evaluation is equal to 0.750593; therefore, it teaches the coordinately dynamic relationship between the variables and finally the standard evaluation error presenting a value of 35.5063 (**Figure 10c**). The mean absolute error (AAE) is 24.6024.

Linear pattern $Y = a + b*x$

Dependent variable (VD): decreasing moisture banana (DMB)

Independent variable (VI): solar radiation banana (SRB)

The effects of linear pattern adjustment refer to the dependency between DMB and SRB.

The equation of the adjusted model below is

$$DMB = -108.201 + 0.38802 * SRB \qquad (5)$$

4.6 Examination of the process by psychometric spread

The leaf concerning psychometric dehydration consents to be able to observe two autonomous methodologies, i.e., at one point, there is a sensitive air heated in the receiver or collector, in which air entering the apparatus is heated at the cost of emissions of solar radiation sponsoring moisture content firmly, and consecutively, in other instances the air develops moisture by vaporizing water in the fruits of pineapple, mamey, and banana as a result of cooling. As an example, in the first process of dehydration of banana fruit, we assume subsequent identifications with their means: air temperature, 26°C; first relative humidity, 72%; air temperature at the dryer inlet as well as the leak in the receiver (collector), 49°C; air temperature in dryer escape, 35.7°C; air channel diameter, 0.08 m; speed of air at the entrance, 16.6 m.s^{-1}; and separate humidity of water, 172.43 g.

4.7 Through these ante-laid characterizations, the movement of the mass fluids was established using the following equations
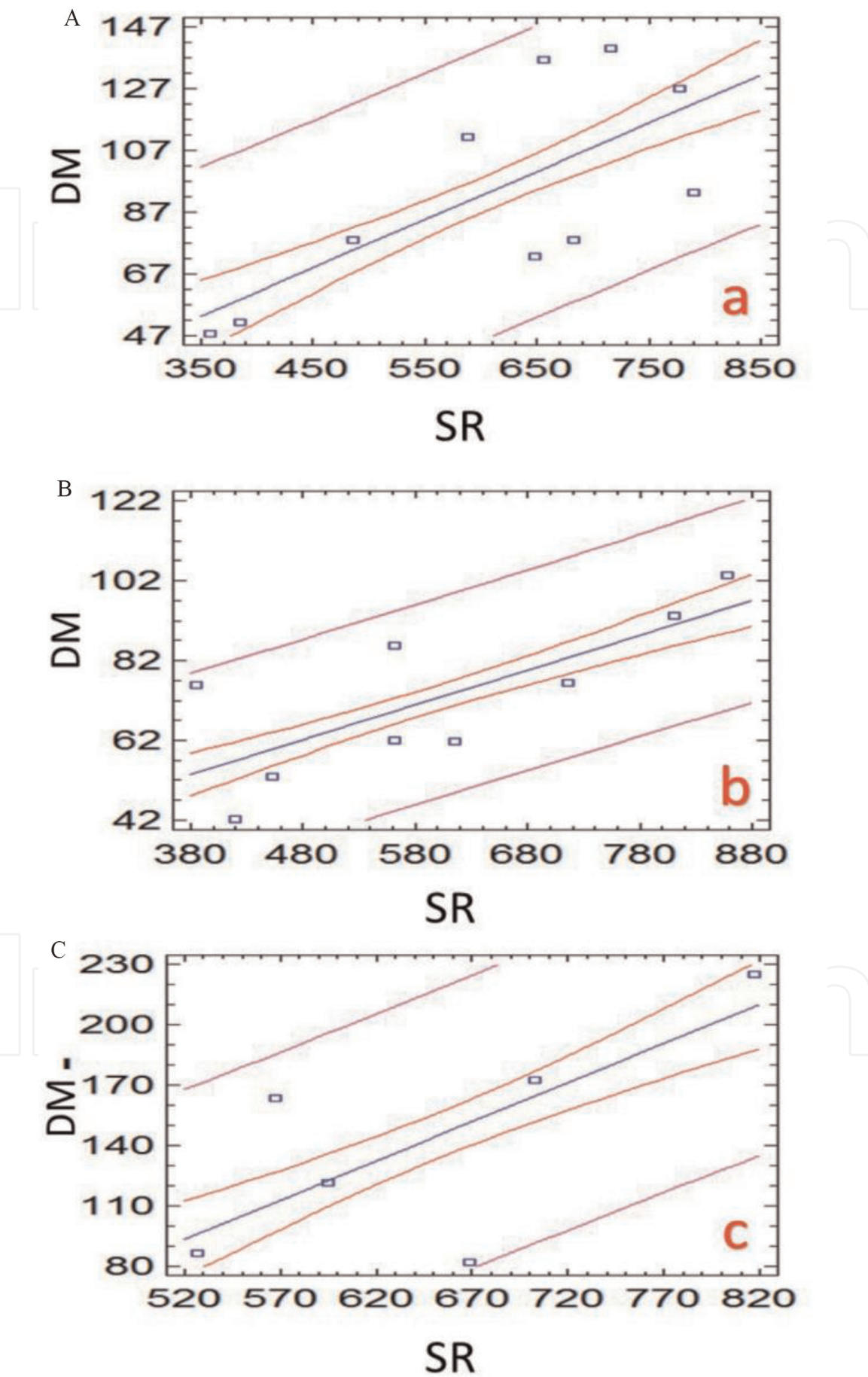
$$W = \frac{\pi * d^2}{4} * V * p \qquad (6)$$

Figure 10.
Pattern provided towards low humidity in fruits dehydrated, (a) pineapple, (b) mamey, and (c) banana, with respect to solar radiation.

where d is the diameter of the air channel and V is the speed of air as well as the air density, resulting in the value of 0.083 kg.s⁻¹. Consecutively after these values and identifying the suppressed humidity of the fruits, the portion of water absorbed in kg of air entering the dryer in the staged phase is established by using Eq. (7):

$$d = \frac{172.43\,g\ water}{1801\,k\ dried\ air} = 0.095\frac{g}{k} \tag{7}$$

In **Figure 11**, you can observe the thermodynamic moments of sites 1, 2, and 3 provided to the air and habitat, in the receiver leak (collector) as well as in the dryer leak; therefore, these identifications, as data taken from psychrometric chart software, manifest the temperature of the dry lamp(DB); relative humidity (RH); absolute humidity (AH); specific volume (Vol); enthalpy(Ent); steam pressure (VP); dew point(DP); and wet bulb temperature (WBT).

The case in process 1–2 was framed concerning reflective heating in the solar receiver (collector), while in other instances in the case corresponding to process
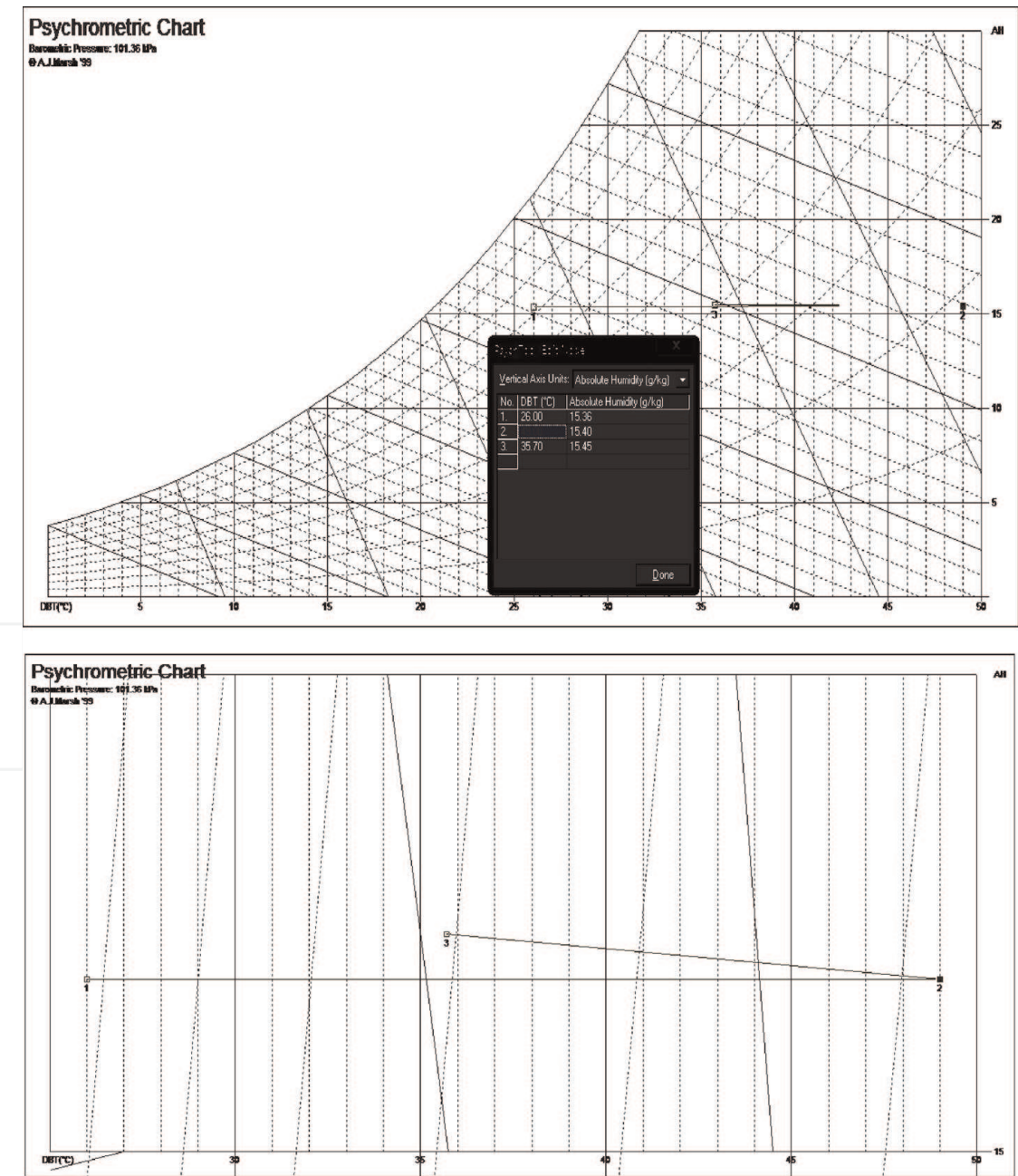

Figure 11.
Examination of the table in collector and solar dryer in the form of a psychometric chart.

2–3 in the inlet dryer, the humidification of the air and its convenient cooling were carried out through the activities of evaporation of water included in the fruits of pineapple, mamey, and banana.

5. Debate

In **Table 1**, we can disclose the percentage (%) of humidity above what was known after the dehydration activities: for pineapple with 86.36%, the moisture content is reduced by an average of X 2.14%, in mamey with 79.30%, by an average of X 21.07%, and for banana with a total of 80.22%, by an average of X 10.35%. The data are consistent with ante positioned knowledge executed by Almada (see [9]). There are also other intellectual citations covered in the mastery of the convective multiflash desiccation process (CMFD) (see [7–11]) are correlated in dried fruits, the inquiry as a study subject, for banana fruit were heated at 60°C by hot air as well as a vacuum pulsation was used, therefore consecutively in the drying of the fruit by medium of the convective drying and dizzying banana vaporization mixture, by CMFD, showed a moisture amount at 0.293 g.g^{-1} (dry base) then in 3 h of process, the pattern of heat diagnosed in banana samples existed through the direction (conduction) and solar luminescence, so they were heated by approximately 60°C, large increases in independent or free water (banana moisture content at 76.00%), coinciding with the illustrations executed (see [10, 11]).

Subsequently in the convective multiflash drying process (CMFD) (about 135 min of process), the banana achieved a moisture amount in 0.29–0.01 g.g^{-1}; finally in the processing, the quantities were 0.276–0.015. The fruits with average amounts of moisture showed a water action ranging from 0.65, 0.85 to 0.90, while the mass of the fruits, due to dehydration, was noted with reduced amount of water and dominoes up to 60.21 g of solid in each repetition of 500 g of dough, mainly because of the water and native mechanisms are transferred to the osmotic procedure from extracellular areas, producing an ascent in the aroma of the fruit as well as well as the texture (see [11, 12]).

This work resolved to disinfect at 180°C for 60 min according to internationally determined rules such as the Medical Research Council; fruits such as banana amounts in 80.22% moisture in fresh state. Together, the validity of the dehydrator was select, assuming the similarity of the convective multiflash drying process (CMFD) method (see [4]) and the solar dryer. In both cases containing the use of solar radiation emission, these being at 300–900 W•m^{-2} (see [13]) the proportion of solar radiation previously and subsequently in the matter of dehydration within the process activities, the banana fruit had a reduction of 80.22–10.35%, exposing that subsequently it is being subjected to 180°C for 60 min a day with a total of 15–30 days. Its index was 0.12% concerning 10.35%, pointing to 0.4 times minimum amount in parallel in banana fruit.

The convective multiflash drying process (CMFD) is a method of efficient dehydration due to two important reasons. Firstly because during flash evaporation, it starts from moisture that encloses internally, so it is pull towards the surface of the fruits, making optimal the convective drying during the movement for heating purposes. Secondly we have to subsequently evaporate the flash, and the fruit is stothered to the surface area of it, making optimal the convective drying during the heating movement as well as later in the evaporation of the flash. The temperature of the fruit drops by 15–20°C, so it transports a relevant difference in the temperature between the hot air and the cooled fruit. We could therefore say that because of this, the fruit receives a better transfer of heat, see [7], a method similar to the procedure or technique assessed in this investigation as the object of study.

Having had on balance, all this provides more accurate and complete assessments of the duration as useful life of dehydrated fruits, in pineapple, mamey and banana individually, of 15–30 days of dehydration process in repetitions, the amount of the shelf life of banana fruit, by sample, see **Figure 5**, as linear regressions with adjusted model of the low humidity of banana fruit in this regard with radiation showed a duration of 109 days, the moisture content of pineapple was reduced from the amount or average riginaria by 86.36% to a final amount of 21.07%; mamey fluctuated between 79.3 and 21.13% and bananas fluctuated between 80.22 and 10.35%, proportionally. As well as, properties such as ash in pineapple at 0.44% had an increase with an average of 1.09%; 0.25% had an increase of 2.66%, and in banana fruit it fluctuated between 1.12 and 2.80%, exposing, in banana farmed fruits, data with more expensive values (data not exposed).

The protein content, as well as fiber, was known a characteristic increase significantly in the previous and subsequent periods in dehydration, is understood as a derivation of fresh pineapple fruit in 0.67% protein and fibers at 2.45% in its fresh phase, together, in dehydrated period, had an increase of 2.45 and 3.63%. The mamey fruit with 0.41% protein and fiber sin at 2.5% in its fresh period, in its dehydrated period, had an increase of 2.55 and 4.94%, proportionally, finally, in banana fruit with amounts of protein type by 1.27 and 0.88% in its fresh, dehydrated time, had an increase of 2.18 and 2.41%, correspondingly.

6. Termination

This work as an object of study in the research assessed the incidences of a solar dryer, which in turn was developed in the city of Calceta, in Bolívar Canton of the Province of Manabí, Ecuador, with the approach of drying to such a point of being able to talk about the phenomena concerning the dehydration of fruits such as pineapple, mamey, and banana. Therefore, trials were carried out as experiments finding, for example, that the organization of the molecular structure of the banana provides the facility for moisture content by means of solar radiation activity.

Then, followed by the pineapple fruit and mamey, as a result, this loss is compressing the moisture content of the valued fruits. The temperature of the drying air is the most important and effective component of several elements of the system during drying; air humidity, as well as air speed, is also a significant factor in optimizing the drying rate. Therefore, in these concerns, it is understood that the microbiological examination helps to establish the shelf life of dehydrated fruits, and it is more important to mention that from 15 to 30 days, repetitions in measured quantities $CFU.g^{-1}$ have given legitimate maximum values, which is understood as a result of the proliferation of microorganisms in the fruits evaluated.

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Dedication

This chapter of the book is dedicated to God, who gives me day-to-day forality to make the daily activities, to my wife Emily Julissa Mendoza Cedeño and daughter

Appendices and nomenclature

Roman symbols

E	solar radiation intensity (W • m^{-2})
A	surface area (m^2)
n	number of experiments
CFU	colony-forming unit
t	temperature
h	specific enthalpy (kJ/kg)
RH	relative humidity
AH	absolute humidity
Vol	specific volume
VP	vapor pressure
DP	dew point
WBT	temperature of wet bulb
R^2	percentage of variation of the variable
Eq.	equation
AAE	average absolute error

Greek symbols

τ	time, min

Subscripts

amb	ambient (at 25°C, 30 wt % relative humidity, 1.012 bar) (kJ/kg)
DM	dry matter
CMFD	convective multiflash drying process
W	water
D	the drying chamber of the drying process
DMP	decreasing moisture pineapple
SRP	solar radiation pineapple
DMB	decreasing moisture banana
SRB	solar radiation banana
DMM	decreasing moisture mamey
SRM	solar radiation mamey

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