Advance Journal of Food Science and Technology 15(SPL): 102-108, 2018
DOI:10.19026/ajfst.15.5879
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: September 14, 2017 Accepted: November 17, 2017 Published: July 10, 2018

Research Article

Agroindustrial Behavior of 11 Mangoes Varieties (*Mangifera indica L*) Present in a Natural Productive System of the District of San Marco de Malagana (Bolívar)

[1, 2]G. Díaz Iván, [1]J. Ahumedo Maicol, [1]Ballesteros Luzneyda and [1]Gonzalez Hannia
[1]Grupo CIPTEC, Tecnología en Producción Industrial, Fundación Universitaria Tecnológico Comfenalco, Cartagena, Colombia
[2]Maestría en Ciencias Agroalimentarias, Universidad de Córdoba, Monteria, Colombia

Abstract: Bolivar department from Colombia, there are many limitations related to production and industrializing of several mangoes varieties. During this exploratory research, there were identified the agroindustrial qualities of 11 mangoes varieties such as fruit mass, lengths, yields, °Brix, titratable acidity, pH and Maturity Degree. Analysis showed a pulp weight average of 70-80%, pH average of 4.5, average °Brix of 15-16 (with the exception of the Azucar variety with 24-27) and average titratable acidity of 0.3 (with the exception of the Masa variety with 0.69). All varieties possess potential features against the standards established by Normas Tecnicas Colombianas NTC 5468 and NTC 285 for fresh type consume and technological transformation in products such as juices, nectar, pulps, marmalades and others. According to the codex (2005) Stan, 4 varieties are in category A (Filipino, Número 11, Rosa and Barba), 4 varieties are category B (Papo, Bota, Corazon and Canela) and the variety Masa is in category C.

Keywords: Agroindustrial, cultivation, fruit, processing, product, properties

INTRODUCTION

Mango fruit (*Mangifera indica* L.), belongs to the *Anacardiaceae* family in the order of *Sapindales*, it is cultivated in so many parts of the world particularly in tropical countries, highlighted by its particular flavor and smell is also considered by some customers like "the fruit´s King" (Lauricella *et al*., 2017; Santos-Villalobos *et al*., 2011), it possesses high acceptation and increase demand in international market. Mango is an agroindustrial product of economic significance for several development way countries and taking into account the FAO (2009a, 2009b) statistics about tropical fruits international exportation it is considered the third fruit more commercialized. Exotic and nutritional properties have prospected an increase in the consumer of mango and its derivatives (Maneepun and Yunchalad, 2004).

Mango is cultivated on a surface of approximately 3.7 million of hectares at world level (Muchiri *et al*., 2012). Among the varieties there is difference into its antioxidant components contents due to genotypes variations, Pre-harvest management factors, edaphoclimatics conditions, agricultural practices and Stage of maturation (Corrales-Bernal *et al*., 2014; Maldonado-Astudillo *et al*., 2016).

Colombia, specifically at Bolivar department, exists several mangoes varieties native (Gliessman *et al*., 1981). These mangoes varieties are identified by natives with names of cultural character or sizes, shape, color and texture (Francis *et al*., 2000). During some interviews, producers make allusion to the huge quantities of this fruit which are not used because the of unknown of its nutritional benefits and some limitations related to the less industrialization of some varieties (Díaz-Gómez and González-Urango, 2014).

Varieties commercialized at national or international scale must be according to internal and external quality regulations. Also must be evaluated the norms about the behavior experiment each variety during the agroindustrial procedure, which allows segmentation of the varieties, destining the less attractive varieties for the fresh fruit market to the derivative production, becoming an alternative to reduce losses during harvesting periods, while maximizing great potential of the fruit, since some varieties commercialized at the local level lack studies that promote the promotion of their consumption for their nutritional and functional contribution which aggregate value to the production chain (Sumaya-Martínez *et al*., 2012).

Corresponding Author: J. Ahumedo Maicol, Grupo CIPTEC, Tecnología en Producción Industrial, Fundación Universitaria Tecnológico Comfenalco, Cartagena, Colombia, Tel.: 3166556843

In Colombia Corpoica directed the search for quality attributes of some native varieties, to be possible their agroindustrial transformation making allusion to the size, weight, performance and firmness of the fruits and also to °Brix, acid and pH for fruits at maturity, in the departments of Antioquia, Tolima, Huila, Magdalena, Cundinamarca, Córdoba and Cesar, For the department of Bolivar, only had reference to the varieties "Hilacha, Papaya and Pecho de Paloma" (Lozano *et al*., 2009), leaving a lot of varieties without evaluation, which is a need and interest for agroindustrial branch developed into the natural production system from San Marco de Malagana (Bolívar).

In the present study the agroindustrial features of 11 mangoes varieties, such as, Total Fruit Mass (TFM), Pulp Weight (PW), Shell Weight (CW), Seed Weight (SW), maturity degree, °Brix, titratable acidity and pH, being the three last ones the most applied physic-chemical features to determinate the agroindustrial significance of that fruit. To verify the behavior of these variables, possible similitude and association to be used an individual way or as a mixture of species to generate production to agroindustrial scale will be used Principal Component Analysis (PCA) described a general way by Salinas-Hernández *et al*. (2010).

Outcomes of this analysis will allow knowing if the varieties possess able potentialities against the standards established by Normas Tecnicas Colombiana NTC 5468, NTC 285 for the fresh fruit consume and/or the technological overcomes into products such as juices, nectar, marmalade and pulps. This research can also be an opportunity for producer families to include some varieties despite their existence are not able into the markets and therefore, to stimulate the interest into those fruit as nutritional alternatives during the fresh fruit consume after the collecting or as a prime material for the overcomes market (Torres-Leon *et al*., 2016; Zhou *et al*., 2017; Zotarelli *et al*., 2017).

MATERIALS AND METHODS

Collecting zone: There were selected 11 mangoes varieties: Rosa, Filipino, Papo la Reina, Corazón, Número 11, Masa, Bota, Azúcar, Barba de Chivo, Canela and Hilaza, named according to the recognized by natives of the zone. They were selected over a non-probabilistic technique in experimental enterprises from Malanga, located the north of the Bolivar department, into the plane surface of the Colombian territory characterized by a hot and wet weather with average temperatures between 26 and 30°C and with an annual average rain of 800 mm.

Physical features: For each variety, it was determined: total fruit weight, pulp weight, shell weight and seed weight. The results were expressed in % according to the total fruit weight. To determinate this total weights, there were taken 10 unities of each variety, each one of them was measured three times and the average was taken as the final value, later it was calculated the average of the 10 unities. To determinate the pulps weight, there were measured 10 kg of each variety after being extracted all the pulp. The percent of the pulp was determined as the relation obtained over 10 kg of mango.

Caliber (mm) and the average size was determined using calibration with an electronic king´s foot to equal numbers of mango per species. Other physical properties such as shell texture, shape, color and smell were equally considered taking into account the standards of the NTC 1226, being ensured by sensorial analysis from researchers not trained.

Chemical features: The percentage of soluble solids in term of °Brix was determined using a Carl Zeiss 844976 Jena refractometer with AOAC. The total titratable acidity was measured using AOAC (Official Methods of analysis of AOAC international (AOAC, 1997)) and expressed as % citric acid. pH was determined using a Starter 3100 pH. Maturity Degree using TSS/TA and taking into account NTC 4580.

Statistical analysis: Data obtained for each one of the parameters defined for each variety were submitted to a statistical analysis determining the minimal and maximal value, the mean and Standard Deviation. Using the statistical software R-project version 3.4.0, which is a free code program. Different mangoes varieties were classified into groups (which possess similar features) thru a main component analysis and clusters. Analysis starts with a matrix consists of 11 row and 8 columns (8×11), which represent the mangoes varieties such as Masa, Papo la Reina, Bota, Corazón, Canela, Filipino, Número 11, Rosa, Barba, Hilaza y Azúcar and the researched variable: Total Fruit Mass (TFM), Pulp Weight (PW), shell weight (CW), Seed Weight (SW), Total Soluble Solids (TSS) represented on °Brix, Titratable Acidity (TA) expressed as % citric acid, hydrogen potential (pH) and fruit Maturity Degree (MD). During the analysis was taken into account the factorial coefficients and their respective approximation to the value one, this value should not be repeated for other variables present in the same component.

RESULTS AND DISCUSSION

Physical features of the 11 evaluated varieties are related to Table 1. In general, mangoes possess oblong shape given their major polar diameter in relation with to the equatorial plane, hardness at contact after hand harvest, pallid yellow color inside as a consequence of the collecting after maturity, as reported standards biochemical overcome related to their featured flavor, color and smell (Briceño *et al*., 2005). The varieties:

Table 1: Physical features of the varieties

Varieties	Shape	Consistency	Color fruit	Color of pulp	Fiber
Masa	Oblique Ovoid	Hard	Yellow-reddish; green; green yellow	Pale yellow	Moderate
Papo	Oblong	Hard	Yellow-reddish; red, green-yellow-red	Pale yellow	Little
Bota	Oblong	Hard	Yellow and red; Green and red.	Pale yellow	Moderate
Corazón	Rounded ovoid	Hard	Yellow and Green	Pale yellow	Little
Canela	Oval Oblong	Hard	Yellow and Green Yellow-reddish; yellow-green-reddish.	Pale yellow	Abundante
Filipino	Reniformoblong	Hard	Yellow and Green Yellow- reddish	Pale yellow	Moderate
Número 11	Oblique Ovoid	Hard	Yellow and Green	Pale yellow	Moderate
Rosa	Oval irregular/rounded	Firm	Yellow and red	Intense yellow	Little
Barba de chivo	Reniformoblong	Firm	Yellow and red	Intense yellow	Moderate
Hilaza	Oval Oblong	Firm	Yellow and Green; yellow	Intense yellow	Abundant
Azúcar	Oval Oblong	Firm	Yellow and Green	Intense yellow	Little

Table 2: Physicochemical parameters of 11 mangoes varieties

Varieties	TFM	%CW	%SW	%PW	TSS	TA(M)	pH	MD
Masa (1)	560	10.4	11.41	78.2	15,5	0.69	4.3	22.5
Papo (2)	514	14.41	7.76	77.83	16	0.25	4.8	64
Bota (3)	507	7.99	6.81	85.2	16,5	0.25	4.6	66
Corazón (4)	453	10.22	6.82	82.96	14	0.25	3.9	56
Canela (5)	360	11.83	9.28	78.9	13	0.29	4.4	44.8
Filipino (6)	328	12.34	9.81	77.85	15,5	0.18	4.5	86.1
Número 11 (7)	299	13.44	10.87	75.68	20,5	0.29	5	70.7
Rosa (8)	262	10.53	7.29	82.18	15,5	0.3	4.4	51.7
Barba (9)	222	13.69	12.46	73.85	15	0.28	4.5	53.6
Hilaza (10)	188	14.92	14.6	70.47	15,5	0.36	4.3	39.7
Azúcar (11)	93	12.75	16.29	70.95	25,5	0.35	4.5	72.9

Número 11, Corazón, Masa, presented some changes related to the maturity process after 3 and 5 days, causing deterioration of the mango. These three varieties suffering from deterioration with dark marks appearing, which help us to identify this speedy process causes the loss of the visual attractive.

The greatest weight corresponds to Masa variety followed of Papo la Reina and Bota, the lowest value corresponds to Azúcar variety. The highest percentage of pulp is 85.2%, 82,96% y 82,18% for the varieties: Masa, Corazón and Rosa, while the lowest goes to Hilaza. Bota variety presented the lowest shell content of 7.99% and the highest pulp with 85.2%, getting a correlation pulp/shell of 10.66 this parameter is an important factor to have as a reference at the time of submitting the varieties to agroindustrial overcomes (Elsheshetawy *et al*., 2016). On average, for the 11 varieties, the ratio pulp/shell corresponds to 6.44. In Table 2 shows the values of the determined Physical Chemistry Properties (PCP) for 11 varieties.

Variable TFM shows the most significate difference among the varieties allowing to determinate fruits caliber taking as base their unity weight, which indicates the number on mangoes to put into the box. The Codex (2005) Stan 184-1993 expresses three categories A, B and C, the varieties investigated are located in the two minor categories A (200-350 g) and B (351-550 g). Highlighting the importance of the minimum weight of 200 g to be placed in the recipe and later marketed.

Highlighting the importance of the minimal weight of 200 g to be collocated into the recipe and latterly commercialized. Colombian regulations considers wider limits and consists of 11 categories A, B, C, D, E, F, G, H, I, J and K. From all them only 7 varieties are located into the categories D, E, F, G with average unity weights of 536 g, 386 g, 352 g, 282 g and Azúcar variety does not classify at any category because its weight is much more inferior to the establish one by K category (140 g). Méndez-Ramírez *et al*. (2010) defines the varieties with weights between 250-600 g can be opportunities at the international market. Troncoso *et al*. (2008), to establish a classification per caliber for the fruits allows to the producer ponderate their product without any distinction type with the goal of promotes it at the international market. This parameter helps the producer to cultivate taking into account the market quality criteria, lined with the physical-chemical features which are also a quality factor.

With respect to the variable seed weight, the highest values were observed at Azúcar (16.2%), Hilaza (14.6%) and Barba de Chivo (12.4%), lowest values correspond to Bota (7.99%) and Corazón (10.22%). Relation SW/TFM takes significance to the industrial branch because it determinates the pulp contents when the relationship is low or gets a minimal parameter of 65% (Méndez-Ramírez *et al*., 2010). Besides, researcher highlights as ideal value the 10% in relation to the seed weight. The varieties: Azúcar (16.26%), Hilaza (14.6%) and Masa (11.41%) possess superior values. Número 11 variety (10.87%) possesses a middle value and the rest of the varieties inferior values being the Corazón variety (6.82%) the lowest one.

Table 3: Analysis of physicochemical parameters

PCP	Min	1st Qu	Mean	3rd Qu	Max	Sd
TFM	93,0	242,0	344,2	480,0	560,0	150,16
CW	7,99	10,46	12,05	13,56	14,92	2,09
SW	6,81	7,53	10,31	11,94	16,29	3,19
PW	70,47	74,77	77,64	80,54	85,20	4,72
TSS	13,00	15,25	16,59	16,25	25,50	3,49
TA	0,18	0,25	0,32	0,33	0,69	0,13
pH	3,90	4,35	4,47	4,55	5,00	0,28
MD	22,50	48,25	57,09	68,35	86,10	17,59

Table 4: Correlation matrix of physical and chemical features

PCP	TMF	CW	SW	PW	TSS	TA	pH	MD
TFM	1,000	-0,504	-0,703	0,700	-0,502	0,224	-0,061	-0,251
CW	-0,504	1,000	0,572	-0,832	0,186	-0,121	0,341	0,089
SW	-0,703	0,572	1,000	-0,931	0,580	0,350	0,065	-0,087
PW	0,700	-0,832	-0,931	1,000	-0,476	-0,182	-0,196	0,018
TSS	-0,502	0,186	0,580	-0,476	1,000	0,060	0,428	0,444
TA	0,224	-0,121	0,350	-0,182	0,060	1,000	-0,209	-0,764
pH	-0,061	0,341	0,065	-0,196	0,428	-0,209	1,000	0,453
MD	-0,251	0,089	-0,087	0,018	0,444	-0,764	0,453	1,000

These values generate an alternative to be applied during the pulp production process when the best behaviors are located in the varieties Bota (85.2%), Corazón (82.96%) and Rosa (82.18%), the minor averages are Hilaza (70.47%) and Azúcar (70.95%), the total average is 77.64% allows probing all the variables are able to be used during this process and also for the fresh consume.

Chemical features: Table 3 show, TSS value is represented as °Brix, the minimum value corresponds to the variety Canela (13°Brix) while the maximal value goes to Azúcar (25,5 °Brix), being 14-18 °Brix the common patron, our mean was 16,59 °Brix, feature is linked to the maturity process. These parameter shows quantities of elements such as glucose, fructose y sucrose, which generate sweetness inside of the fruit just like happens with our 11 varieties, which depends on the physic-chemical state during the collecting and some increase depends on the maturity process (Quintero *et al*., 2013; Torres *et al*., 2013).

On researches about pre-established varieties, Edward, Glenn, Irwin, Otts y Parvin, (Vargas-Simón *et al*., 2000), defines the importance of finding values between 15 y 22 °Brix, classified as "very nice". Taking into account this reference, the 11 mango varieties with TSS features can attribute some relevance during the juice production process taking into account this branch possesses a very solid and positioned commercialization level (8-15% for non-concentrated drinks, which is the result of the mixture of pulp and water.

Titratable acidity values expressed as % citric acid presented minimum, maximum and middle value of 0.18, 0.69 and 0.32 respectively, (Table 3) while pH values are 3.90, 5.0 and 4.47 respectively, being the varieties: Masa (0.69), Hilaza (0.36) and Azúcar (0.3). Número 11 variety was the most pH (5.0), while the varieties with minor acid and pH are Filipino (0.18) and Corazón (3.9).

Analyzing TSS/TA relation to verify acid, sweet or less sweet (Ascens *et al*., 1980), was found values of 86.1 for Filipino, 72.85 Azúcar, 70.68 Número 11, 66 and 64 for varieties Bota and Papo, characterized as less acid or sweet. The lowest relation is 22.46 for mass variety, which is commercialized in a green state because of its lightly sweet flavor related to its 15.5°Brix, this variation allows using the subjective character at the time of consuming. Número 11 variety and their TSS (°Brix) features can have some relevance during the process of juice production because the solids outcome levels in this kind of product oscillate between 8% and 15% for non-concentrated drinks. They can also be employed during soft drinks production adding the 1% of the soluble solids taking as reference Resolution 3929/2013 from Ministerio de Salud y Proteción Social, Colombia.

Correlation matrix: A correlation matrix was made between the physicochemical parameters of the mangoes varieties studied as seen in Table 4, with the goal of clearly defining Principal components. It was found positive correlations TMF with PW and TA; CW with SW and pH; SW with CW, TSS and TA; PW with TMF; TSS with SW, pH and MD; TA with SW; pH with CW, TSS and MD; MD with TSS and pH, taking into account a parameter of values between -1 (minimal value) and 1(maximal value).

Principal component analysis: Table 5 shows 8 matrix components (Component Number), each Principal component´s own value (Eigenvalue) explicated variance (Percentage of variance) and the accumulate variance expressed into percentage values (Cumulative percentage). The explanation of the variance allows identifying the number of Principal components to use during the analysis. The three first ones main components were taken as reference for the present research and they explain the components

Table 5: Principal components, own values, explained and accumulated variances corresponding to physical-chemical variables

Component number	Eigenvalue	Porcent of variance	Comulative porcentage
1	3.5822790	0.4477849	44,77849%
2	2.1463270	0.2682908	71,60757%
3	1.0153550	0.1269194	84,29952%
4	0.8730505	0.1091313	95,21265%
5	0.2401477	0.0300184	98,21449%
6	0.1018937	0.0127367	99,48816%
7	0.0409463	0.0051182	99,99999%
8	3.8163E-07	4.770E-08	100,0000%

variation in an 84.29%, because of accumulation of the major classification criteria contents. This value is represented it by the maximum variance found into the first component with an explanation of 44.77%, followed by 26.82% and 12.69% into the second and third component respectively with a sequence of descendent values until 100% into the 8 component.

Physicochemical parameters PW and TFM showed a high correlation with the first main component, while for the second component were TA, SW and TFM, CW is directly correlated with the third component like Table 6 shows, being PW the variable with major incidence over component 1, while TFM is repeating it into the second component despite it represents a minimum value. The final equations in terms of the three components are:

Equation 1. First component: Z_1 = 0,429149362TFM-0,403857439CW-0,466321413SW+0,495291339PW-0,364204383TSS+0,005843652TA-0,197331792pH-0,135432664MD

Equation 2. Second component: Z_2 = 0,429149362TFM + 0,01581626CW+0,27275226SW-0,1911061PW-0,14209137TSS+0,59286279TA-0,35686543pH-0,135432664MD

Equation 3. Third component: Z_3=-0,29462709TFM + 0,35236582CW-0,05244238SW-0,12110434PW-0,57105237TSS-0,47000903TA-0,47191074pH-0,04367715MD

It can be observed that value of the first component is explained by the total fruit mass, shell weight, seed weight, pulp weight, total soluble solids, titratable acidity, pH and degree of maturity. The variables that contribute most to the component are pulp weight, seed weight and total fruit mass. In the second component, variables that most contribute are the titratable acidity and total mass of the fruit and in the case of the third component, we have the weight of the shell.

Formation or classification by groups for the varieties taking into account their capacity of identifying and analyzing data due to the complex interpretation in bidimensional planes when there exist several variables lined to similar varieties number, which, thru the set analysis facilitate determination of similar elements (Gallegos-Vázquez *et al*., 2006).

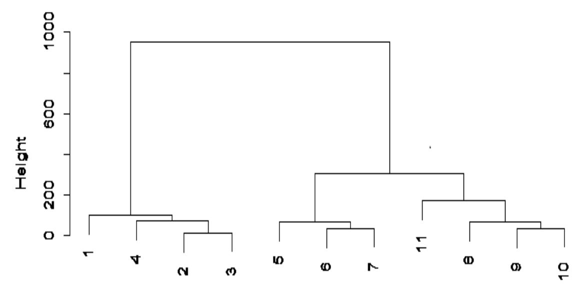

Fig. 1: Classification and grouping of different mangoes varieties taking into account their physical-chemical features

This researches probed, using this procedure, two elements groups (Fig. 1), the first one formed by the varieties Azúcar, Barba, Hilaza, Número 11, Papo and Filipino; a second one formed by the varieties Bota, Rosa, Canela, Corazón and Masa. The first group is characterized by having major percentages of seed and shell, minor total mass, minor pulp percentage and acceptable levels of total soluble solids. The second has a major pH and maturity degree and minor titratable acidity. This information allows us making this grouping taking into consideration the features and agroindustrial behaviors. Table 7 collects all this information previously described to be used during the of mixed products elaboration thru development of potentialities mixtures with the goal of decreasing the presence of some additive such as sugar synthetic.

Above classification allows encouraging the change of criteria in the consumer and the agroindustrial sector, regarding the acceptance of unknown varieties in their local production environment. It also encourages the development of agroindustrial research projects that will show the high functional value of these varieties in the region's production chain.

On the other hand, potentialities of 11 varieties studied can be taken into account by local and national producers to strengthen marketing policies focused on the direct transaction with family producers, which at some point will allow positioning of new varieties in the productive chains, as has happened with other varieties among which the Irvingia excelsa "Agbono" known as African mango, (Ugwumba *et al*., 2013) can be mentioned. The data obtained throughout the investigation show that there are similarities in other

Table 6: Correlation between the physical-chemical features and main corresponding to the physical-chemical changes of 11 researched mangoes varieties

PCP	Component 1	Component 2	Component 3
TFM	0.429149362	0.04249042	-0.29462709
CW	-0.403857439	0.01581626	0.35236582
SW	-0.466321413	0.27275226	-0.05244238
PW	0.495291339	-0.1911061	-0.12110434
TSS	-0.364204383	-0.14209137	-0.57105237
TA	0.005843652	0.59286279	-0.47000903
pH	-0.197331792	-0.35686543	-0.47191074
MD	-0.135432664	-0.62289637	-0.04367715

Table 7: Varieties potentialities by product type highlight the significant/unique findings

Varieties	Potentiality	Products
Hilaza	This variety is the one that presents agroindustrial value in the area	Juices
Azúcar	It has good features, but low performance, which makes it very expensive	
Corazón Numero 11 Masa	They print a sweet taste, have good texture, characteristic aroma, and good yield	Nectar
All varieties	They are useful for sweetened pulp, given the production volumes, it is recommended a mixture of different varieties.	Pulp
All varieties	It is possible to eliminate the humidity in all.	Dehydrated fruits
Barba de Chivo Numero 11 Papo	From the combination with some additives, they can match the maximum allowed pH level (4.5).	Hot sauce
Corazón	It has a good relationship between the degree of maturity and the sweetness. Good performance and low fiber.	Jams and jellies
Filipino	It allows a good stability in the sugar-pulp concentration. It should not be used in a state of physiological maturity, as it exceeds the required pH levels.	
Hilaza	Meets all flavor-aroma-texture specifications.	
Azúcar	Good flavor-aroma-texture ratio, because of its marked taste, can fuse its pulp with others that have less flavor like Cinnamon and Rosa or any other variety.	

research regarding the behavior of some mango varieties, among the parameters that are evaluated (Soto *et al*., 2015).

CONCLUSION

Although there are differences in the physicochemical properties of the evaluated varieties, the results of the research showed that all varieties have expected characteristics of quality for fresh consumption in the domestic market and some of them can be considered for international market.

According to the Codex (2005) stan, 4 varieties are in category A (Filipino, Número 11, Rosa and Barba), 4 varieties are category B (Papo, Bota, Corazon and Canela) and the variety Masa is in category C, Hilaza and Azucar varieties do not fall into these categories.

Corazón, Filipino, Papo, Bota, Número 11, Hilaza and Azúcar varietiespreviously characterized possess some properties and feature similar in relation to °Brix despite the ranch of some variables such as weight. For varieties Masa, Papo, Bota, Rosa and Barba, there was the first identification exercise.

We conclude that mangoes varieties represent a potential as raw material for the development of the productive mango chain in the region, becoming a great for local producers to gain access to special markets where consumers place emphasis on the exotic character.

ACKNOWLEDGMENT

The author´s acknowledgment to the Fundación Universitaria Tecnológico Comfenalco for economic support for the investigation and also to the whole community of the town of Malagana for opening the doors to one of its main wealth.

REFERENCES

AOAC, 1997. Official Method of Analysis. 15th Edn., AOAC, Washington, DC, USA.

Ascens, J.C., A.V. Milheiro, M.I. Mota and M.M. Cabral, 1981. Seleção preliminar da mangueira. Pesq. Agropec. Bras., 16(3): 417-429.

Briceño, S., J. Zambrano, W. Materano, I. Quintero and A. Valera, 2005. Calidad de los frutos de mango 'Bocado', madurados en la planta y fuera de la planta cosechadas en madurez fisiológica. Agron. Trop., 55(4): 461-473.

Corrales-Bernal, A., M.E. Maldonado, L.A. Urango, M.C. Franco and B.A. Rojano, 2014. Mango de azúcar (*Mangifera indica*), variedad de Colombia: Características antioxidantes, nutricionales y sensoriales. Rev. Chil. Nutr., 41(3): 312-318.

Díaz-Gómez, I. and H. González-Urango, 2014. Fichas técnicas de doce (12) cultivares de mango (*Mangifera indica* l) del corregimiento de malagana, zona norte del departamento de bolívar, Colombia. Proceeding of the 4th Simposio Internacional Agroalimentario. Montería, Córdoba, Colombia.

Elsheshetawy, H.E., A. Mossad, W.K. Elhelew and V. Farina, 2016. Comparative study on the quality characteristics of some Egyptian mango cultivars used for food processing. Ann. Agric. Sci., 61(1): 49-56.

FAO (Food and Agriculture Organization of the United Nations), 2009a. Investing in Food Security. FAO, Rome, Italy.

FAO (Food and Agriculture Organization of the United Nations), 2009b. The State of Food Insecurity in the World. FAO, Rome, Italy.

Francis, J.K., C.A. Lowe and S. Trabanino, 2000. Bioecología de arboles nativos y exóticos de puerto rico y las indias occidentales. General Technical Report IITF-15, International Institute of Tropical Forestry, Rio de Piedras, Puerto Rico.

Gallegos-Vázquez, C., R.D. Valdez-Cepeda, M. Barrón-Macías, A.F. Barrientos-Priego, J. Andrés-Agustín and R. Nieto-Ángel, 2006. Caracterización morfológica de 40 cultivares de nopal de uso como hortaliza del banco de germoplasma del crucen-uach. Rev. Chapingo Serie Hortic., 12(1): 41-49.

Gliessman, S.R., R.E. Garcia and M.A. Amador, 1981. The ecological basis for the application of traditional agricultural technology in the management of tropical agro-ecosystems. Agro-Ecosystems, 7(3): 173-185.

Lauricella, M., S. Emanuele, G. Calvaruso, M. Giuliano and A. D'Anneo, 2017. Multifaceted health benefits of *Mangifera indica* L. (Mango): The inestimable value of orchards recently planted in sicilian rural areas. Nutrients, 9(5): 525.

Lozano, J.C., Q.J.A. Floriano, J.P. Corredor, E.J.A. Bernal, L.A. Vásquez, A.P. Sandoval, F.F. Longas and G.G. Barros, 2009. Descripción de Las Variedades de Mango Criollo Colombiano. Boletín Técnico, Colombia, Corpoica, pp: 72.

Maldonado-Astudillo, Y.I., H.A. Navarrete-García, O.D. Ortiz-Morales, J. Jiménez-Hernández, R. Salazar-López, I. Alia-Tejacal and P. Álvarez-Fitz, 2016. Propiedades físicas, químicas y antioxidantes de variedades de mango crecidas en la costa de guerrero. Rev. Fitot. Mex., 39(3): 207-214.

Maneepun, S. and M. Yunchalad, 2004. Developing processed mango products for international markets. Acta Hortic., 645: 93-105.

Méndez-Ramírez, R., O. Quijada, G. Castellano, M.E. Burgos, R. Camacho and R.C. Marin, 2010. Características físicas y químicas de frutos de trece cultivares de mango (*Mangifera indica* L) en el municipio mara en la planice de maracaibo. Rev. Iberoam. Tecnol. Postco., 10(2): 65-72.

Muchiri, D.R., S.M. Mahungu and S.N. Gituanja, 2012. Studies on mango (*Mangifera indica*, L.) kernel fat of some Kenyan varieties in meru. J. Am. Oil Chem. Soc., 89(9):1567-1575.

Quintero, V., G. Giraldo, J. Lucas and J. Vasco, 2013. Caracterización fisicoquímica del mango comun (*Mangifera indica* L.) durante su proceso de maduracion. Biotecnol. Sect. Agropec. Agroind., 11(1): 10-18.

Salinas-Hernández, R.M., M.É. Pirovani, A.A. Gardea-Béjar and G.A. González-Aguilar, 2010. Physicochemical and sensory changes that limit shelf-life of fresh-cut mangoes. Rev. Fitotec. Mex., 33(3): 215-223.

Santos-Villalobos, S., S. de-Folter, J.P. Délano-Frier, M.A. Gómez-Lim, D.A. Guzmán-Ortiz, P. Sánchez-García and J.J. Peña-Cabriales, 2011. Puntos críticos en el manejo integral de mango: Floración, antracnosis y residuos industriales*. Rev. Mex. Cienc. Agríc., 2(2): 221-234.

Soto, E., N. García, R. Vergara, G. Ettiene and E. Pérez, 2015. Physical and chemical characteristics of tommy atkins mango fruits (*Mangifera indica* L.), according to their maturity and management systems resumen. Rev. Fac. Agron. (LUZ), 32: 476-494.

Sumaya-Martínez, M.T., L.M. Sánchez Herrera, G.T. Garcia and D.G. Paredes, 2012. Red de valor del mango y sus desechos con base en las propiedades nutricionales y funcionales. Rev. Mex. Agron., 30: 826-833.

Torres, R., E.J. Montes, O.A. Pérez and R.D. Andrade, 2013. Relación del color y del estado de madurez con las propiedades fisicoquímicas de frutas tropicales. Inform. Tecnol., 24(3): 51-56.

Torres-Leon, C., R. Rojas, J.C. Contreras-Esquivel, L. Serna-Cock, R.E. Belmares-Cerda and C.N. Aguilar, 2016. Mango seed: Functional and nutritional properties. Trends Food Sci. Tech., 55: 109-117.

Troncoso, J.L., M. Aguirre, P. Manriquez and D. Mundigo, 2008. Influencia del calibre, mercado de destino y mes de comercialización en el precio de exportación de la palta hass: Un enfoque hedónico. Cienc. Invest. Agr., 35(3): 333-339.

Ugwumba, C.O.A., G.I. Wilcox and C.O. Aniaku, 2013. Economics of irvingia excelsa "agbono" kernel production in nsukka local government area of enugu state, Nigeria. ARPN J. Agric. Biol. Sci., 8(5): 399-404.

Vargas-Simón, G., R.M. Soto-Hernández, M.T. Rodríguez-González and J.A. Escalante-Estrada, 2000. Análisis fitoquímico preliminar del fruto de icaco (*Chrysobalanus icaco* L.): Flavonoles y flavonas. Rev. Chapingo Ser. Hortic., 6(2): 195-198.

Zhou, L., Y. Guan, J. Bi, X. Liu, J. Yi, Q. Chen, X. Wu and M. Zhou, 2017. Change of the rheological properties of mango juice by high pressure homogenization. LWT-Food Sci. Technol., 82: 121-130.

Zotarelli, M.F., V.M. da Silva, A. Durigon, M.D. Hubinger and J.B. Laurindo, 2017. Production of mango powder by spray drying and cast-tape drying. Powder Technol., 305: 447-454.