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Effect of Packaging Conditions on Microbiological and Physicochemical Quality of Moroccan Date Fruit

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ABSTRACT

The packaging effect on the date fruit quality was assessed in one hand in order to prove microorganisms multiplication of the sample dates, the results by the PCA method showed that no packaging date are grouped together witch contaminated by microorganisms and how have a negative effect for date quality. In other hand, we considered it useful to study the physicochemical profile of different varieties of dates to ensure on the correlation of biochemical parameters and microbial contamination. High correlations were obtained between microorganism contaminations in no-packaging date, which have a negative effect for date fruit quality. For physicochemical characteristics, the results showed a positive correlation between the sugar concentration and moisture parameters with a value of 0.779. Concerning physicochemical parameters and the microbial growth were correlated with a low correlation, neither between the sugar concentration and the microorganism count, except for the sugar content and the ASR, which correlated to 0.605.

Keywords: Date fruit, Packaging, Physicochemical, Microbiological, PCA

INTRODUCTION

The date palm (*Phoenix dactylifera* L.) plays very important socioeconomic and environmental roles in desertic area [1]. Morocco is the sixth worldwide date producer country with over than 4.8 million date palm, distributed in many regions such as Ouarzazate, Errachidia, Tata, Tiznit, Goulmim, Figuig, Marrakech and Agadir. The annual date production in the country fluctuates enormously according to climate conditions, especially the rainy or drought season. In a normal year, the total production is above 100,000 tons, of which 25% have a high quality (Mejhoul, Boufeggous, Bouskri, and Aziza bouzid), 35% medium quality and 40% can be ranked as a lower quality. Date commercial sector in Morocco undergoes the impact of several imperfections [2], like the storage conditions which lead to enzymatic and microbiological spoilage and consequently mycotoxins contamination**.** Besides that, dates fruits are consumed at Tamar stage where it has good storability, sweet taste and lower astringency. The chemical composition of date fruits was reported in many studies. These fruits are rich in simple sugars like glucose and fructose (65-80%) [3], which can be a good substrate for fungi contamination [4]. The present study is oriented to investigate Packaging effect on date quality and to ensure correlation between the chemical composition of date fruit and their microbial quality contamination.

MATERIALS AND METHODS

Plant materials

Dates samples varieties was obtained from the wholesale market in Fez city of Morocco, date varieties are non-packaged dates “Abourar, Bouskri, Klane, Mejhoul, Khalt, Rassltmer, Tarzawa, Jihel, Boufeggous, Bouslikhenes” and packaged date” Deglet Nour, Deglet Baida and Lulu”. The samples were sealed separately in aseptic packages and transported in the icebox to the laboratory. Thereafter, samples are stored at 4°C until analysis.

Methods

Microbiological analysis

Samples (10 g) of dates were aseptically weighed into sterile stomacher bags and 90 ml sterile Ringer solution (NaCl 0.9%) was added. Samples were then homogenized for 10 min and aliquots were used for microbiological analysis. Bacterial and fungal colonies were counted and expressed as colony forming units ($CFU.g1^{-1}$). To determine the total viable count, 1 ml aliquots from suitable dilution (10^3-10^5) were transferred aseptically into sterile Petri-dishes. To each dilution 10-15 ml, inoculums was mixed well with the melted medium and allowed to solidify. The plates were then incubated at 37°C for 24-48 h [5]. ASR (Anaerobic Sulfite Reducing) bacteria were enumerated using SPS Agar at 46°C for 48 h [6]. Potato Dextrose Agar medium was used for selective enumeration of yeast and Malt Agar medium. For selective enumeration of molds, the plates were incubated at 30°C for 7 days.

Chemical analysis

To determine the moisture content. Two 10 g of pulp were spread out in a tarred stainless capsule and then dried in oven at 80°C until constant weight was reached. Results are expressed as percent of dry weight [7]. pH values were determined using the method of [8]. Four grams of date pulp were dispersed in a flask with 200 ml of boiling water. After cooling, the flask was made up to volume with distilled water. Then pH was determined by pH-meter. The total sugars were estimated by the Anthrone method [9].

Statistical analysis

All values are the means of three independent experiments presented as mean ± standard deviation (X ± SD). The Tukey's test and one-way analysis of variance (ANOVA 1) were used to compare results with α=5%. PCA analysis was established by XLSTAT-Excel 2007.

RESULTS AND DISCUSSION

Quantification of the microbial flora isolated from dates

Table 1 shows the triplicate means values of the microbiological analysis of dates. The results show that the contamination is dominated by the TAMF (Total Aerobic Mesophilic Flora), ASR (Anaerobic Sulfite Reducing) and fungi.

Table 1: Average values of microbial contamination of samples expressed by Log_{10} CFU/g

Varieties	Molds	Yeast	FMAT	ASR
Abourar	3.2^{a}	4.8^{ab}	4.9^{a}	3.5^{g}
Bouskri	3.5^{a}	4.1^{b}	4.1^{c}	3.9^{b}
Klane	3.6^{a}	4.3^{ab}	4.5^{b}	3.6^{f}
Mejhoul	3.3^{a}	3.9^{b}	4.9^{a}	3.2^{i}
Khalt	3.3^{a}	4.3^{ab}	4.4^{b}	3.8^{d}
Rassltmer	3.7^{a}	4.6^{ab}	4.5^{b}	3.9^{c}
Tarzawa	3.5^{a}	4.5^{ab}	4.4^{b}	3.7^{f}
Jihel	3.8^{a}	4.5^{ab}	4.5^{b}	3.3^{h}
Boufeggous	3.3^{a}	4.9^{a}	4.8^{a}	4.9^{a}
Bouslikhène	3.5^{a}	4.8^{ab}	4.4^{b}	3.5^{e}
LuLu	0.5^{b}	0.6^{d}	0.6^{e}	0.6^{j}
Deglet nour	0.6^{b}	0.6^{d}	0.7^{e}	0^{k}
Deglet Baida	3.3^{a}	3.1^{c}	3.3^{d}	0^{k}

In order to compare microbial strain distributions in different varieties of dates studied, we have done variance analysis (ANOVA1) established by XLSTAT-Excel 2007. The results (Table 2) show that the differences are significant at $P < 0.05$ limit regarding the germs distribution in different varieties of dates analyzed. Viewing the approximation between the average values of microbial load in the analyzed samples of dates, we decided to do variance analysis according tukey method. In order to make dates into categories belonging to closer groups, the results show a clear presence of a group of organisms based on growth factors in existing dates. This grouping somehow reflects the interaction between microorganisms and growth or inhibition factors in dates studied.

Table 2: Variance analysis (ANOVA1) for molds, yeasts, FMAT and ASR

	F test	Probability (5%)	Critical value for F
Molds	20.092236	$3.7595.10^{-10}$	2.14792623
Yeast	35.371442	$5.1344.10^{-13}$	2.14792623
FMAT	234.04765	$2.6707.10^{-23}$	2.14792623
ASR	78.328571	$2.9391.10^{-17}$	2.14792623

This study reveals that dates consumed in Fez city region are contaminated with bacteria, molds and yeast. Contamination is predominated by the FMAT with an average value between 3 log 10 cfu/g and 4.5 log 10 CFU/g (Table 1). These results agree with those reported by Al Jasser et al., who found FMAT average load, with different samples of dates from several parts of Saudi Arabia, is 3 log 10 CFU/g [10]. This dissimilarity may be explained by the huge difference of climatic conditions. Low microbial loads founded in packed date such us lulu, Deglet Nour and Deglet Baida varieties suggest to us that either these dates contain growth inhibitors of germs or they are undergoing treatment before they are marketed [10].

Quantification of chemical composition from dates

Table 3 shows the average chemical composition of date flesh from the *P. dactylifera* L. cultivars. The results showed that physicochemical values are similar for either the packed or no packed dates.

Table 3: Chemical composition of date fruit

	Date variety	Moisture	Sugar	pH
non-packaged dates	Abourar	$26.7^{b} \pm 1.13$	$71.0^{cde} \pm 0.78$	$6^{a} \pm 0.01$
	Boufeggous	$26.7^{b} \pm 0.64$	$83.3^{a} \pm 0.26$	$5^{a} \pm 0.04$
	Bouskri	$25^{bcd} \pm 0.23$	$69.0^{de} \pm 0.20$	$6^{a} \pm 0.10$
	Bouslikhène	$27^{b} \pm 0.80$	$74.0^{bc} \pm 0.53$	$6^{a} \pm 0.02$
	Jihel	$24^{cd} \pm 1.00$	$71.0^{de} \pm 1.00$	$6^{a} \pm 0.02$
	Khalt	$26^{bc} \pm 0.85$	$76.0^{b} \pm 0.35$	$5^{a} \pm 0.03$
	Klane	$23.6^{cd} \pm 0.55$	$74.0^{bcd} \pm 0.50$	$5^{a} \pm 0.01$
	Mejhoul	$30.2^{a} \pm 0.93$	$81.0^{a} \pm 1.14$	$6^{a} \pm 0.01$
	Rassltmer	$20^{e} \pm 0.10$	$71.0^{de} \pm 0.20$	$5^{a} \pm 0.02$
	Tarzawa	$19^{e} \pm 0.85$	$72.2^{cd} \pm 0.72$	$5^{a} \pm 0.01$
packaged dates	Deglet Nour	$24^{cd} \pm 0.95$	$73.1^{cd} \pm 0.12$	$5^{a} \pm 0.01$
	Deglet Baida	$15^{f} \pm 0.06$	$57.8^{f} \pm 1.00$	$5^{a} \pm 0.01$
	Lulu	$23^{d} \pm 1.50$	$69^{e} \pm 1.00$	$6^{a} \pm 0.01$

Table 3 shows that the majority of dates fruits are sold in non-packaged form. Moisture is one of the essential components of the fruit, which underline its quality and acts on its conservation. Results showed that this parameter ranged from 19 to 30% (Table 3). Al-Shahib et al., considered dates as soft if they present a water content more than 30%, dry if this rate is less than 10% and haf-soft if the rate is between 10 and 30% [11]. This categorization permits us to classify the littoral date as soft dates.

The dates had a high carbohydrate content it's well known that dates are important sources of sugar, and total sugar content was similar to that reported previously 72.8-79.1% [11]. These height values of sugar can be present a matrices of microbiological contamination.
For pH values, the result showed that this parameter is ranging between 5 ± 0.01 and 6 ± 0.10 during maturation ripping. Theses lower pH values can be explained by the presence of organic acid. This potential hydronium value is very favorable for yeasts and molds growth, this is confirmed by our study in 2013 [4].

Correlation between microbiological contamination in date fruit and their chemical composition

A statistical analysis was performed in order to identify the possible correlation between physicochemical parameter and microbial count. The high sugar and water content in date fruit which favors the development of microbial contamination.

The results showed that microorganisms between them have good correlation which is proved by person test of correlation (Table 4). For physicochemical characteristics the results showed a positive correlation between the sugar concentration and moisture parameters with a value of 0.779. Concerning physicochemical parameters and the microbial growth were correlated with a low correlation, neither between the sugar concentration and the microorganism count. Except for the sugar content and the ASR, which correlated to 0.605.

Amada et al., proved in their study that the conversion of glucose into gluconic acid by the enzyme glucose oxidase can also decrease its osmotic pressure and allow the development of some fermentative microorganisms able to release acidic compounds [12].

Table 4: Correlation between microbial contamination and physicochemical parameters in date fruit

Variables	Molds	Yeast	FMAT	ASR	Moisture	Sugar	pH
Molds	**1**	**0.946**	**0.947**	**0.73**	0.002	0.088	-0.036
Yeast	**0.946**	**1**	**0.977**	**0.868**	0.186	0.289	0.009
TAMF	**0.947**	**0.977**	**1**	**0.841**	0.248	0.333	0.035
ASR	**0.73**	**0.868**	**0.841**	**1**	0.438	**0.605**	0.051
Moisture	0.002	0.186	0.248	0.438	**1**	**0.779**	0.514
Sugar	0.088	0.289	0.333	**0.605**	**0.779**	**1**	0.002
pH	-0.036	0.009	0.035	0.051	0.514	0.002	**1**

The values in bold are different from 0 to a significance level alpha = 0.05

Principal component analysis for date fruit distribution

The principal component analysis (PCA) was realized in order to study dates fruit profiles between date packed and date not-packed, all the data obtained on the date fruit shows that 82.48% of the variability of the data is extracted by the factorial plane F1 X F2, where the first axis explains 52.27% of the variance and reflect microbiological contamination parameters. A first group in the positive part of the axis F1 which present date packed such us (Mejhoul, Boufeggous, Bouslikhene, Abourar, Khalt, Bouskri, Jihel, Klane, Rassltmer and Tarzawa) characterized by high contamination by ASR, FMAT, Yeast and Molds. A second group where the variable structuring negatively F1 is dates packed such as Lulu, Deglet Nour and Deglet Baida varieties, this can be explained that these dates contain either growth inhibitors of germs or they are undergoing treatment and packed before they are marketed. While the second axis, which represents 30.22% of the variance, are marked mainly by physicochemical parameters. The results showed that Rassltmer, Tarzawa and Deglet Baida correlated negatively with other types of dates; this can be explained by their moisture content, which is declared by low levels compared to the other dates fruits analyzed (Figure 1).

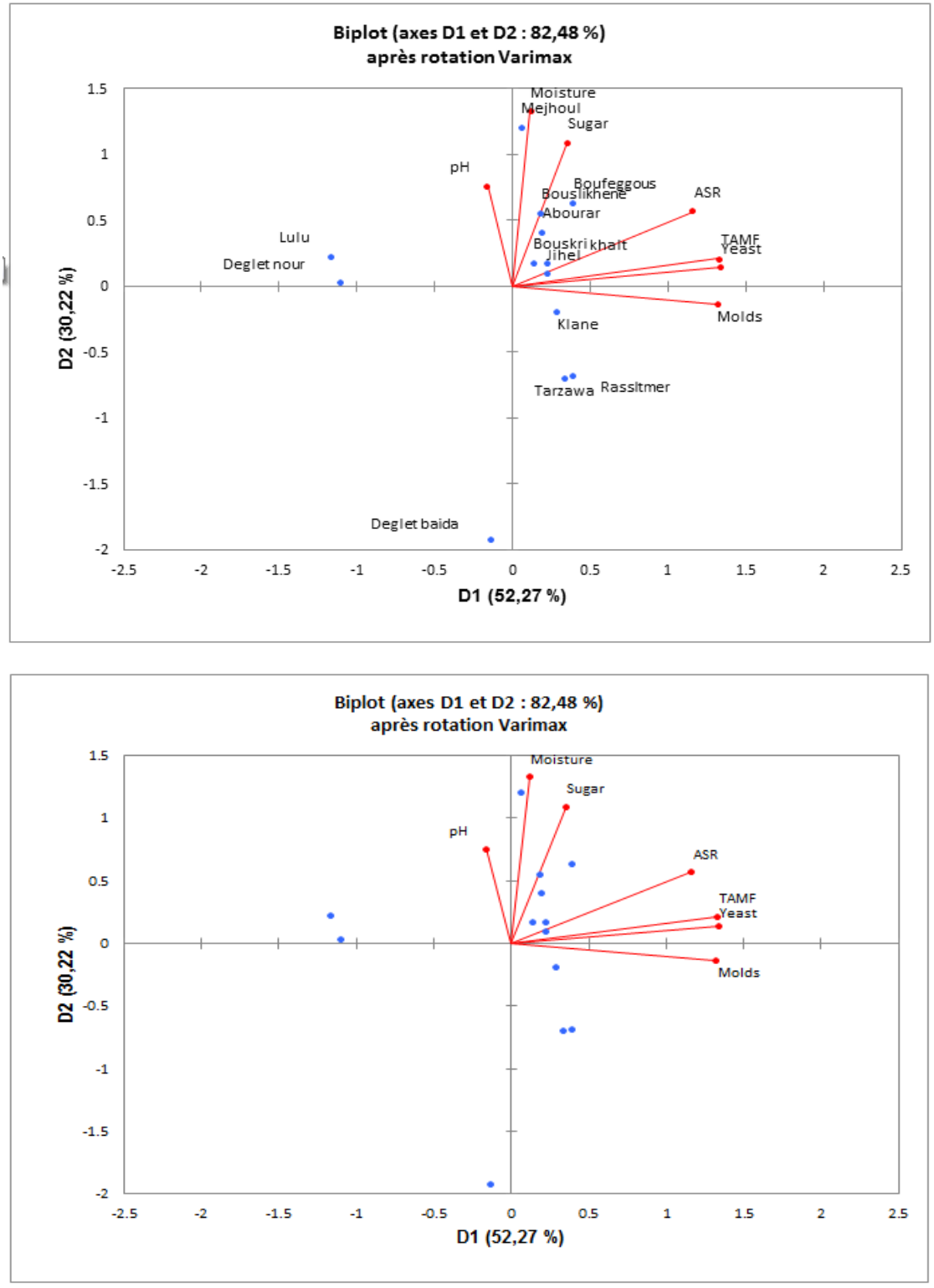

Figure 1: Principal component analysis for date fruit distribution

CONCLUSION

This study recommends that, the improvement of harvest and handling methods (Storage, grading and packaging) of dates in Morocco. Since the date fruits are usually sold in open places, and found to be contaminated with microbial microorganism, which may be pathogenic, we suggest that the general principles of food hygiene should still be enforced in order to minimize contamination. Which we must restore the notion of packaging in order to preserve our heritage plant and encourage its commercialization under the right conditions.

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