

Evaluation of contaminant kinetics in tetra-pack conditioned juice: evolution of the physico-chemical and microbiological parameters during the storage period.

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ABSTRACT/RESUME

Abstract: Packing is the new operations in the manufacture of food products, they will help maintain the hygiene, tactile and nutritional quality of the food and meet the logistical constraints. A study was conducted to determine the effects of packaging materials, storage temperature, and time on physicochemical and bacteriological properties of conditioned juice. pH, acidity, Brix, mineral content (heavy metals before and after contact, in packaging and in juice), migration test, microbiological analysis, and antioxidant activity (FRAP) were evaluated in freshly prepared juice, and after 15, 30, 45, 60, 75, and 90 days of storage at room temperature. A migration test was conducted using three percent acetic acid as a simulator followed by an Atomic Flammings Adsorption Spectroscopy analysis of the tested packaging and analysis by TF- IR of the product. The results showed that pH, acidity, Brix, decreased with storage times. According to the results obtained no variability was observed for the microbiological parameters during the storage period. As for the physicochemical parameters, minor variations have been observed. The loss of total phenols and vitamin C content was higher in juice stored at 90 days than 15 days. The results of mineral analyzes show a slight variation of 1 to 2 mg / l compared to the reference sample (0-day storage sample), for K +, Na +, Cl- and PO4-3, with the exception of calcium ion, for which there was a sharp increase after 45 days of storage, which then declined. The findings showed the lack of migration of the packaging to the food, thus maintaining the initial composition.

I. Introduction

In recent years, an increase of interest in conditioned juice and packaging quality is observed in many communities. This is due to increased consumer awareness in the aspect of search for the products rich in health-promoting components (G Kowalska et al.,2020).Fruit juices are nourishing beverages, in a healthy diet can play a major part because a variety of nutrients found naturally in fruits, also offer good taste. Juices exist in natural concentrations or processed forms. Fruit juices are available in any place in the world are available in bottles, cans, laminated paper packs, pouches, cups and almost every other form of packaging in the diet of most people, irrespective of age included significantly

thus, it contribute to good health (Tasnim et al., 2010).

Juices contain vitamins, especially vitamin C, folic acid and vitamins from group B, as well as minerals mainly manganese and potassium but also magnesium, phosphorus, zinc , calcium, and selenium, which are naturally present in the components in fruits and are related to the uptake of elements by plants from the natural environment (air, water, soil) [Fathabad AE et al.,2018]. Another factor to be considered is the effect of production conditions and packaging materials on the mineral contents in the ready-for-consumption product; hence, the materials that do not add undesirable components to enriching food should be selected as

the packaging material (Rodushkin I and Magnusson A. 2005; Fan Y-Y et al.,2014)

Heavy metal contamination of fruit juice, vegetables, and other crops is a major concern in the world, the recent recherche prove their accumulation in food in elevated concentrations could cause serious risk to human health if it is consumed (D Vousta et al., 1996; D.J.Ashworth et al., 2004) according to Okoronko (N E Okoronkwo et al., 2005), heavy metals have been detected in vegetables and fruits at levels that exceed the standard recommends. although some heavy metals have no harmful effects in plants, metals like copper, zinc, and iron are essential elements in the body of the plant due to their physiological functions. The essential elements are very important because they are involved in many enzyme systems in the human body. However, high concentrations are toxic (D M Miller and W P Miller, 2000).

A major issue remains the question of the effect of container form on product quality (Siegmond et al., 2004). It may be responsible for various contaminations (chemical, physical, and microbiological) (Konko and al, 2004).

For this purpose, polymers usually can not be considered as ideal packaging materials, as several interactions are likely to occur with the product it self or with the environment through several phenomena; permeation, migration and sorption; leading to various effects.

A large number of investigations have been published describing these phenomena and providing in-depth reviews of the possible interactions between juice and packaging material by Nielsen and Jagerstad (1994), Fayoux and al. (1997), and Askar (1999).

Despite these drawbacks, stratified cardboard packaging has been commonly used as containers for fruit juices and nectars, as they provide a range of advantages.

The main objective of our analysis is to determine the evaluation of a locally fabricated orange juice will experience over a particular period of time, while observing the kinetics of the contaminants, and taking into account the physico-chemical and bacteriological parameters involved: pH, temperature, acidity, contact time, heavy metals, minerals and other.

II. Materials and methods

The samples that were the topic of our research were packed in an aseptic tetra packaging (1l of volum). A batch of 150 bottles held at room temperature for three months was dedicated to testing the kinetics of various forms of pollutants. All juice samples were analyzed initially and at regular intervals of 15 days and for 3 month.

II.1. Microbiological analysis

The microbiological quality of the juice was assessed on the basis of total Viable Bacterial Count (TVBC), Total Coliform Count (TCC), and Total Fungal Count's (TFC) using Plate count agar (PCA), MacConkey agar (MCA), and Potato Dextrose agar (PDA), respectively. Juice samples were spread onto these plates and incubated at 37°C for 24 hr except for detection of fungi, which were incubated at 25°C for 5 days (**Normes JORA N° 35 27-05-1998**).

II.2. Heavy metals analysis of the juice

50 mL of each juice sample was placed into a 250 mL beaker. 50 mL of aqua regia prepared from analytical grade concentrated 36% HCl and concentrated 63% HNO₃ was added. The mixture was covered with a watch glass, heated, and reflux on a hot plate. Additional 10 mL of the aqua regia was added and the heating continued until the color was very light yellow. The last step was repeated and the solution evaporated until the volume was about 15-20 mL. The solution was cooled and 10 mL of 30% H₂O₂ (AR) added and heated without boiling until effervescence was minimal to ensure complete digestion. The heating was continued and the volume reduced to about 10 mL. The beaker was removed from the hot plate cooled and the walls washed down with double distilled. The digest was filtered using Whatman No. 4 filter paper into a 50 mL volumetric flask and then diluted with double distilled water to the 50 mL mark. All the digested samples were analyzed for As, Cr, Pb, Se, Sb, Ba, Hg, and Cd using Inductive Coupled Plasma Atomic Emission Spectrometer (ICP).

II.3. Mineral analysis of the juice

The Concentrations of five trace elements (Ca, PO, Na, K, and CI) were analyzed in all juice samples. In this research, 2 mL of each juice samples were taken into vessels. 20 mL of mix concentrate nitric acid-hydrogen peroxide (9:1, v/v) were added to each vessel and well shaken and kept at room temperature for 10 min until the samples were homogenized. Afterward, the vessels were retained in the covered Polytetrafluoroethylene (PTFE) container. As next step, for 15 min samples were heated (at 80 % of total power (1800 W)) following one-stage digestion programmed. After cooling, to eliminate the extra acid, the subsequent solutions were evaporated to semi-dried mass, and afterward diluted up to 50 mL in volumetric flasks with deionized water and retained as a stock sample solution. Total Ca, PO, Na, K, and CI concentration were determined spectrophotometry according to the Standard method (**Karbouj, 2008**).

II.4. Chemical analysis

Acidity, pH, migration test and soluble solid were analyzed initially and at regular intervals of 15 days and for 3 month. pH was measured using pH meter (ISO 1842 :1991). Acidity was determined according to the method of NF V 05-101 (1974). Soluble solids were determined with a refractometer, according to the method of Arfa, (2008).

II.5. Determination of ewect on DPPH radical

The effect of extracts on DPPH radical was estimated according to the method of Yen et Duh, (1994). The juice samples were diluted with methanol and added to a methanolic solution (2 mL) of DPPH radical (the final concentration of DPPH was 6×10^{-5} M). The mixture was shaken vigorously and left standing at room temperature for 1 min; the absorbance of the resulting solution was then measured spectrophotometrically at 517 nm. Ascorbic acid was used as a reference. Lower absorbance values of the reaction mixture indicated higher free radical scavenging activity. The capability of scavenging the DPPH radical was calculated by using the following formula.

$$\% \text{ inhibition} = \{(A_0 - A_e)/A_0\} * 100$$

Where, A_0 is the absorbance of the control reaction, and A_e is the absorbance in presence of all of the juice samples and references.

III. Results and discussion

III.1. Microbiological analysis

In order to estimate the microbiological quality (stability) of the juice during the storage period (90 days) a series of microbiological analysis (total germs, total Coliforms, yeasts and molds) was conducted, the results are shown in the following table.

Table 1 . Result of microbiological analysis

Flora (CFU/ml)	Days								Norms (JORA N°35.19 98)
	0	15	30	45	60	75	90		
total germs (37°C)	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs	20
total germs (22°C)	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs	<100
total Coliforms	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs
fecal coliforms	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs
yeasts	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs
molds	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs

The findings of the microbiological study of the studied juice, processed under normal temperature and humidity conditions for 90 days, show a complete absence of contaminants (totals germs, totals Coliforms, yeast and molds, etc.).

This means that it is of very good meteorological consistency, since the latter follows a closed circuit and undergoes pasteurization at an appropriate temperature and time to ensure the optimal microbiological quality.

Microbiological tests were carried out on a juice packed in a tetra pack, confirmed the good microbiological quality of the packaging and inspected that this type of packaging prevents all microbial proliferation by using a film made of aluminum and polyethylene and maintains the nutritional quality of the food under optimal storage conditions (Arfa, 2008).

Several experiments performed on a juice packaged plastic bottles without prior pasteurization and those with pasteurization demonstrated significant bacterial proliferation in the case of non-pasteurization, suggesting that the packaging design does not affect the microbiological effect quality of juice.

III.2. Physico-chemical analysis

The juice thus packaged in a tetra pack and stored at room temperature, undergoes a range of physico-chemical analyzes, namely pH, acidity, Brix, mineral content

Table 2. Evolution of pH, acidity and brix degrees of orange juice during storage at 25 ° C (in tetra pack).

Days	pH	Acidity (g/l)	Brix
0	3.63 ±0.137	3.02 ±0.12	11.63± 0.55
15	3.56± 0.012	3.28 ±0.04	11.8± 0.10
30	3.55± 0.00	2.99 ± 0.10	11.9±0.00
45	3.43±0.00	3.16± 0.04	12 ± 0.00
60	3.43 0.021	2.88± 0.08	11.93± 0.06
75	3.43±0.015	2.88±0.00	11.57± 0.12
90	3.3 ± 0.08	2.88±0.00	11.5±0.00

According to the results, the evolution of the pH at 25 ° C is characterized by a gradual decrease throughout the storage period, and which meets the values set by the GMPs of this company (3, 35 - 3.45), as well as the guide to good hygiene practice in the Algerian industries of fruit juices, nectars and derived products (December 2011).

This considerable decrease in pH is mainly due to the addition of citric acid, or even ascorbic acid. There is a significant rise in acidity after 30 days of storage as per the results obtained. In the last 3 samples, which reflect values in compliance with

this company's GMP (2.9-3.2), a remarkable acidity stability was noted beyond 45th days.

This acidity is closely related to pH, it can be primarily attributed to the introduction of citric and ascorbic acid or alcoholic fermentation, this interpretation is supported by the research done by Echeverria and Valich (1989) and that of Bourokaa (2012), which provided that this acidity can also be attributed to malic acid in introduction to citric acid and ascorbic acid and, to a lesser degree, to succinic acid.

This acidity results in a pH between 3.0 and 3.5 (Nagy and Shaw, 1990), usually between 0.5 and 1.1 grams of citric acid per liter of juice. In addition to its essential role in orange juice's tangy taste, acidity has a profound effect on the sensory experience of the juice's volatile compounds.

According to the results obtained, we note that the brix values meet the values required by the GMPs of this company (11.9 ± 0.2), with a slight decrease after the 75th day of storage, this may be due either partial fermentation of added sugar or sugar from fruit. This hypothesis is confirmed by the work carried out by Echeverria et al. (1989).

These results also comply with the national legislation of the importing country, which has set a minimum Brix value for reconstituted fruit juices and reconstituted purees between 11.8 and 11.23 at 20 ° C. It is understood that the Brix value varies according to the geographical areas (ALINORM 05/28/39, 2005).

The delegation of Brazil believed that a provisional brix value of 11.5 was better than the absence of value (FAO / WHO 2003).

The delegations of the EC and the Russian Federation argued for a minimum Brix value of 11.2, which was close to that indicated in the Codex Standard for Oranges (11.0) (Codex STAN 245-2004), and which would ensure the palatability of the product in the European Community and the Russian Federation, as well as the value used in certain markets. Many delegations who have spoken on this issue have stated that they share this point of view (ALINORM 05/28/39, 2005).

Table 3. Results of mineral analyzes.

Days	Ca ⁺⁺ (mg/l)	Po4 ⁻³ (mg/l)	Na ⁺ (mg/l)	K ⁺ (mg/l)	Cl ⁻ (mg/l)
0	12.5	9.67	60	5.3	17
15	11	10.33	54	5.8	18
30	11	10.67	57	5.8	17
45	21	10.67	56	5.8	17
60	11.5	10.67	58	5.9	16
75	11.5	12.33	59	5.9	17
90	10.5	10.67	51	5.9	17

The results obtained show a slight variation of 1 to 2 mg / l compared to the reference sample (0-day

storage sample), for K⁺, Na⁺, Cl⁻ and PO₄⁻³, with the exception calcium ion, for which there was a sharp increase after 45 days of storage, which then declined.

The contribution of mineral salts to the flavor of orange juice is not very well understood. However, Bourokaa (2012) found that these salts have an important role in the sensory property of the juice. Park and al (1983) stated that potassium is the most abundant mineral in orange juice. Its concentration, as well as those of sodium, magnesium and calcium depend on the harvest period of the raw materials. In general, the mineral content of oranges tends to decrease as the season progresses. Roussef and Nagy (1987), for example, observed a highly significant positive correlation between the potassium content and the degree of preference of an orange juice by consumers.

It is understood that mineral salts cause "salting-out" phenomena, i.e. promoting the release of volatile compounds from the aqueous phase to the vapor phase, and requiring a salt concentration (Leland, 1997).

III.3. Antioxidant activity

The figure below (fig.01), shows the results of the evolution of the anti-radical activity (percentage of DPPH radical inhibition) as a function of different concentrations of the studied juice compared to the control ascorbic acid.

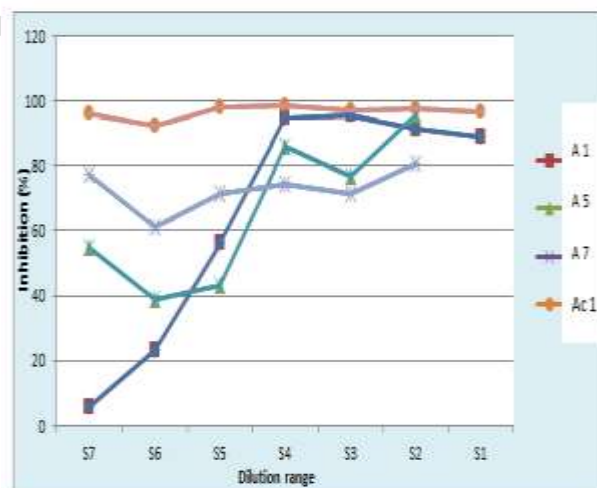


Figure 01. Temporal evolution of antioxidant activity (DPPH).

Assay 1: juice sample corresponds to the 15th day of storage; Assay 5: juice sample corresponds to the 60th day of storage; Assay 7: juice sample corresponds to the 90th day of storage; AC1: Control Ascorbic Acid solution; S1, S2, S3, S4, S5, S6, S7: corresponds to the dilutions made for each sample from 10⁻¹ to 10⁻⁷.

During the first four dilutions, the percentage of inhibition remained stable for the three samples tested. This can be explained by a strong radical scavenging power and a high concentration of ascorbic acid in the juice.

There is a small discrepancy between the inhibition curves of the different samples, which may be attributable to a minor degradation of ascorbic acid as a result of the duration of the juice's physicochemical properties (acidity) and temperature storage.

According to Sizer and al., (1988) the temperature and the duration of storage seem to be the most critical factors favoring the degradation of vitamin C. Indeed, a study by Roschmillas and al., (2007); shows that the retention of ascorbic acid in orange juice packaged in PET bottles was significantly higher at 4 °C than at 25 °C. This is confirmed by other authors: Kabasakalis and al., (2000); Ayhan and al., 2001; Zerdin and al., (2003) and Esteve and al., (2005).

Other studies have found that ascorbic acid can also break down in the absence of oxygen. In an acidic and hot environment, ascorbic acid undergoes dehydration and decarboxylation which lead to the formation of intermediate products, carbon dioxide and furfural (Huelin and al., 1971). This anaerobic degradation has been observed in orange juice during storage (berlinet, 2007).

Thus, many bibliographic works have testified that orange juice during its storage is a very reactive medium. Its parameters of nutritional and organoleptic quality are affected, among other things, by temperature, storage time, oxygen content (Polydera and al., 2003; Zerdin and al., 2003).

At the end of the fourth dilution, the percentage of inhibition of the control solution remains stable unlike the 3 samples of the juice this can be explained by the resistance of synthetic ascorbic acid compared to natural.

A gradual decline in the first sample curve is thus observed, this is explained by a correlation between n ascorbic acid concentration and inhibition percentage (khoudali and al. 2014).

As for the last two samples, a slight increase at the seventh dilution took place due to different possible reactions between the different intrinsic constituents of the juice.

III.4. Research of contaminants (heavy metals)

Until looking for contaminants (heavy metals) and their evolution over the storage period, it is important to first search for them in the packaging before contact.

III.4.1. Heavy metals in packaging and juice before contact

The results are illustrated in the following table

Table 04. heavy metals changes during storage time of fruit juices and packaging materials before interaction treatment.

Juice		Packaging			
Heavy metals	Norms	Heavy metals	Norms (mg/kg)		
As	-	As	<11	-	-
Se	-	Se	69	-	-
Sb	-	Sb	100	-	-
Ba	-	Ba	< 600	-	-
Cr	0,225	Cr		0,25	
Cd	0,096	Cd		0,5	ENV 12 498 (Pb, Cr, Cd) ENV 12 497 (Hg)
Hg	-	Hg	<1	0,3	
Pb	0,054	Pb		3	
Cu	0,031	Cu	-	-	-
Fe	0,100	Fe	-	-	-
Zn	0,4966	Zn	-	-	-

III.4.1.1. Heavy metals in packaging

According to the results obtained, and taking into account the packaging composition (21% of PET, 4% of aluminum and 75% of the cardboard), we note that the values of certain metals are considerably high compared to the standards in particular Cr, Cd and Pb which generally enter into the composition of printing ink.

Barium (Ba), antimony (Sb) and selenium (Se) represent important contents, because they enter the alloy composition (EDQM, 2014), as bulking agent, used in the manufacture of paperboard, they can also be found in the form of impurities.

On the other hand, an amount of Arsenic (As) (11ppm) has been found, this may be due to its role in papermaking. It is an adhesive for metals (such as aluminum), as it can be found in certain alloys intended to be in contact with food or in special brasses obtained by adding certain additional elements such as: Sn, Al, Mn, Ni, Fe and Si, making it possible to improve the mechanical properties of packaging and to reinforce their resistance to corrosion (resistance, permeability, rigidity, surface, ...) (EDQM, 2014).

III.4.1.2. Heavy metals in juice

According to the results obtained and illustrated in Table 5, it is found that values are higher or lower for Cr and Cd compared to the standards.

Indeed, Cr is generally present in all foodstuffs in trivalent form. It is found in fruits, in small quantities (0.1 mg / kg). According to a study by (Nordic and al., 1995), he found that Cr generally comes from food processing (the case of orange fruits in juice).

As for Cd, it is generally found in most foodstuffs at a concentration ranging from 0.005-0.1 mg / kg of food (Freiberg and al., 1986). The lowest values are found in dairy products and beverages (European Commission, 2004).

In this work, it should be noted that the values of Pb Zn, Fe and Cu comply with standards (see table 5), these compounds are considered to be primary metabolites naturally present in the plant matrix (Regulation 1935/2004).

III.4.2 Evolution of heavy metals during the storage period

The results of the analysis of heavy metals after the contact obtained are illustrated in the following table.

Table 05. Evolution of heavy metals in packaging samples (from 15 to 90 days).

days	Without contact	0	15	30	45	60	75	90	SRL (mg/kg)
Cr	<8	<8	<5	<8	<6	<11	<9	<8	0,250 (EFSA, 2010)
Hg	<1	<1	<1	<1	<1	<1	<1	<1	0,003 (P-SC- EMB)
Cd	<30	<30	<30	<30	<30	<30	<30	<30	0,005 (EU Council Directive 98/83 / EC)
As	11	10	10	10	12	11	12	11	0,002 (P-SC- EMB)
Sb	<100	<60	<90	<70	<70	<80	90	90	0,04 (EFSA , 2004)
Se	69	66	69	69	69	68	64	69	-
Ba	600	500	500	600	600	600	600	600	1,2 (P-SC- EMB)
Pb	7	6	7	6	8	7	9	9	0,010 (P-SC- EMB)

SRL : specific release limit.

According to the results obtained in **table.5**, it can be seen that the concentration of heavy metals remains unchangeable, with a slight variation from one sample to another for some, of which it is less than 10 ppm for Sb, less than 2 ppm for As and the Pb, less than 5 ppm for Cr and less than 100 ppm for Ba. However, variations in the content of Arsenic (As) are probably due to external pollution.

For Antimony (Sb): a remarkable decrease of less than 30 ppm by adding to the control sample (<100 ppm), this variation is directly related to the concentration of antimony in the PET because it is combined and used as catalyst in the form of Sb2O3

at high temperature, at a concentration of 300 mg of Sb / kg of plastic in its production phases, which in certain cases causes the increase in the migration of this element in the food (OFSP, 2007).

Mercury (Hg) and Cd: contents obtained are correlated with the results of the control sample, they are however not in conformity with the standards, and do not change during storage.

For chromium and lead: The values show a slight variation in addition to the control sample (<3 ppm), this variation results from their use as a pigment for paper (Cr) and printing ink (Pb) (EVM, 2002).

III.4.2.2 Evaluation of heavy metals in juice

The results of the heavy metal consultations in the juice are summarized in the following table:

Table 06. Evolution of heavy metals in juice samples (from 15 to 90 days)

Days Heavy metals	Without Touching	15	30	45	60	75	90
Fe	0,100	0,138	0,103	0,099	0,082	0,090	0,074
Cu	0,031	0,037	0,054	0,019	0,041	0,023	0,007
Pb	0,054	0,049	0,058	0,026	0,053	0,022	0,050
Zn	0,4966	0,2261	-	0,369	0,1638	0,0605	0,0187
Cd	0,096	0,116	0,102	0,104	0,103	0,127	0,113
Cr	0,225	0,202	0,162	0,405	0,073	0,740	0,505

Iron: No considerable variation is noticed. Indeed, the presence of small amounts of Iron in the 7 samples may be the consequence of its use as food colors, and of the use of its soluble salts as pigment in materials in food contact (Beliles, 1994), as it can come from food processing equipment (case of juice).

For copper: the concentrations vary from one sample to another, but they always remain below the standard (see table 4). Indeed, Cu is naturally present in the foodstuff in particular in the juice (EU-RAR, 2008).

Lead: the results obtained are close to the norm, Pb can seep into the ground and can be absorbed by the fruits intended for the manufacture of juice, (Panisset and al., 2003).

For Zinc: the contents obtained are lower compared to the standard, according to the ATSDR (2005), Zn is used as a galvanized alloy and anti-rust in materials in contact with food in very limited quantities.

Cadmium: Cd contents are lower in juice compared to other foods (Panisset et al., 2003). In our case, they are slightly higher than the norm.

The main sources are the use of Cd in the manufacture of plastic (PET layer) and its transfer from the soil to the edible parts of plants (fruits).

Chromium: there are more or less considerable variations compared to the control sample and standards, this content results from its use in the manufacture of paper and generally comes from the process of food processing by robots or kneaders (EVM, 2002).

III.4.3. Global Migration Test

In this case, 03% acetic acid was used with a test duration of 2 hours, the results obtained for all of the samples revealed a migrat concentration of less than 1 ppm, supposed a quantity of migrat less than 0.16 mg / dm² of packaging, which complies with the limits authorized by the instruction of August 29, 1991 and by the decree of January 02, 2003, making reference to European directives 82/711 / EEC, 85/572 / EEC, 89/109 / CEE, 2002/72 / CE relating to plastic materials and articles placed or intended to be in contact with foodstuffs, products and food beverages, appeared in the official journal of January 29, 2003.

The analyzes carried out by the flame SAA after overall migration test, did not give any remarkable change in terms of heavy metal concentration for all of the samples (see Table 06). This justifies the absence of migration (meets LLS standards), knowing that this material (packaging) has its own LLS.

Since the first layer of contact with our drink is PET, and according to the study carried out by AFSSA which demonstrated that at 25 ° C the diffusion of migrants in PET is much too slow to be detectable, this justifies the results that 'we obtained (Feigenbaue and Barthélémy, 2006).

A study on the water / PET interaction and migration tests at 40 ° C for 10 days and simulated with 3% acetic acid revealed results not exceeding 1.5 µg / l of food (calculated for a 1.5-liter bottle). This value is valid for migration in water and in aqueous and acidic foods and beverages (Barthélémy and Feigenbaum, 2006). For this exposure (1.5 µg / person / day), the health risk is statistically low, since few chemicals are capable of inducing cancer with a probability of 1 in 1 million.

The CSHPF and the AFSSA have also adopted an exposure threshold of 1.5 µg / person / day as the toxicological concern threshold, provided that there is an additional examination of the chemical structure. The Council of Europe also specifies that the toxicological evaluation of substances whose migration is less than 0.5 µg / kg of food or 1.5 µg / person / day consists in ensuring that they are not carcinogenic, for example by verifying that they do

not contain any structural reason for warning of carcinogenesis (SCF, 2000).

VI. Conclusion

This work present data on the concentrations of minerals and heavy metals in commercial fruit juices present on Algeria market. No contamination was detected in the food according to the results obtained, which was confirmed by mineral and heavy metal analysis, as well as ascorbic acid analysis. In addition, the tetra pack in contact with the orange juice matrix is an inert material at ambient temperature and humidity throughout the entire storage period and can in no way alter the physico-chemical and bacteriological of juice characteristics. Also, the absence of migration of the constituents (from juice) to the packaging was found. The present study makes it possible to highlight the absence of interaction between tetra packaging style packaging and liquid food (Juice) packaging and to ensure its ability to protect the latter against the various deterioration factors, which means that it is listed as one of the best packaging intended to be in contact with the food.

finally, other storage condition (time and temperature), packaging and food for other items must also tested, for example, packaging for cosmetics, medicine, chemicals ... and other.

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