

Shelf-life assessment of an orange beverage based on physicochemical, microbiological, and sensory analyses

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Abstract

This study aimed to evaluate the physicochemical, microbiological, and sensory stability of an orange-based beverage during storage at ambient temperature. Samples were collected at different stages of production (raw materials, semi-finished, and finished products) and analyzed over a four-month period (T0–T4). Physicochemical parameters, including pH, Brix, titratable acidity, pulp content, vitamin C, phenolic compounds, color intensity, and density, were monitored. Microbiological analyses were performed according to Algerian standards, and sensory evaluation was conducted using a trained panel. The results showed that pH, Brix, and density remained relatively stable throughout storage, while significant changes were observed in titratable acidity, pulp content, vitamin C, phenolic compounds, and color intensity ($p < 0.05$). A marked decrease in vitamin C and phenolic compounds, along with an increase in color intensity, indicated progressive quality degradation. Microbiological analysis revealed the absence of microorganisms in the early stages; however, yeast contamination appeared after two months and increased significantly over time. Sensory evaluation demonstrated that color, aroma intensity, freshness, and pulp content were significantly affected by storage duration, whereas other attributes remained stable. In conclusion, the orange beverage exhibited satisfactory initial quality but showed significant deterioration in physicochemical, microbiological, and sensory properties during prolonged ambient storage. These findings highlight the limitations of ambient storage conditions and emphasize the need to reassess shelf-life claims and improve preservation strategies to ensure product quality and safety.

Keywords: Orange beverage, Shelf-life, ambient storage, physicochemical properties, Microbiological stability, Sensory analysis.

Évaluation de la durée de conservation d'une boisson à base d'orange par des analyses physicochimiques, microbiologiques et sensorielles

Résumé

Cette étude vise à évaluer la stabilité physicochimique, microbiologique et sensorielle d'une boisson à base d'orange stockée à température ambiante. Des échantillons ont été prélevés à différentes étapes de la production (matières premières, produit semi-fini et produit fini) et analysés sur une période de quatre mois (T0–T4). Les paramètres physicochimiques étudiés incluent le pH, le degré Brix, l'acidité titrable, la teneur en pulpe, la vitamine C, les composés phénoliques, l'intensité colorante et la densité. Des analyses microbiologiques ont été réalisées selon les normes algériennes, et une évaluation sensorielle a été conduite par un panel entraîné. Les résultats montrent une stabilité du pH, du Brix et de la densité, tandis que des variations significatives ont été observées pour l'acidité titrable, la teneur en pulpe, la vitamine C, les composés phénoliques et l'intensité colorante ($p < 0,05$). Une diminution marquée de la vitamine C et des composés phénoliques, ainsi qu'une augmentation de l'intensité colorante, indiquent une dégradation progressive de la qualité. Les analyses microbiologiques révèlent l'absence de contamination initiale, mais une apparition de levures après deux mois de stockage, avec une augmentation notable au fil du temps. L'analyse sensorielle met en évidence des changements significatifs de la couleur, de l'intensité aromatique, de la fraîcheur et de la teneur en pulpe. En conclusion, la boisson présente une qualité initiale satisfaisante, mais subit une détérioration significative au cours du stockage prolongé à température ambiante, soulignant la nécessité de réévaluer les conditions de conservation et la durée de vie du produit.

Mots clés: Boisson à l'orange, Durée de conservation, Stockage à température ambiante, Propriétés physicochimiques, Qualité microbiologique, Analyse sensorielle.

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INTRODUCTION

The food industry, driven by increasing demand associated with population growth, is continuously evolving, particularly in the beverage sector. Among these products, fruit juices occupy a significant place, offering a wide range of options from fresh juices to processed beverages that meet diverse consumer preferences (El Gozmir & Chouhbi, 2023). Fruit juices are often perceived as beneficial to health due to their richness in vitamins, antioxidants, and bioactive compounds (Mekhalfa et al., 2022).

However, ensuring product quality remains a major concern for both producers and consumers. Food quality encompasses several aspects, including hygienic quality related to food safety and commercial quality associated with sensory attributes and texture (Delacharlerie et al., 2008).

Storage at ambient temperature represents a critical stage in beverage

preservation, as it can significantly affect physicochemical, microbiological, and sensory characteristics. Inadequate storage conditions may lead to product deterioration, ranging from minor sensory changes to potential health risks (FAO, 2007).

The present study aims to evaluate the effect of ambient storage on the physicochemical, microbiological, and sensory properties of an orange-based beverage in order to better understand degradation mechanisms and identify strategies to preserve product quality and safety.

The objective of this study is to evaluate the physicochemical, microbiological, and sensory stability of an orange beverage during storage at ambient temperature, with particular emphasis on quality control at different stages of production (raw materials, semi-finished, and finished products).

MATERIAL AND METHODS

1. Study Location and Period

The study was conducted at the COJUNA production unit in Blida, Algeria. Physicochemical and microbiological analyses were carried out in the COJUNA laboratories and the quality control laboratory in Agropastoralism Research Center CRAPAST over a period of four months.

2. Biological Material

Samples were collected from different stages of the production process. Three critical sampling points were identified: raw materials (treated water, orange pulp, and white syrup), semi-finished product, and finished product. All samples were collected under aseptic conditions.

3. Storage Conditions

The orange beverage samples were stored at ambient temperature and analyzed periodically (T0 to T4) to monitor changes over time.

4. Physicochemical Analyses

The following parameters were measured: pH, Brix, titratable acidity, pulp content, vitamin C content, color intensity, phenolic compounds, and density. Standard analytical methods were used for all measurements.

5. Microbiological Analyses

Microbiological tests were performed to detect mesophilic bacteria, total and fecal coliforms, *Staphylococcus aureus*, yeasts, and molds, according to Algerian standards.

6. Sensory Analysis

A sensory evaluation was conducted using a trained panel. The assessed attributes included color, consistency, aroma, sweetness, acidity, astringency, bitterness, freshness, and pulpiness. Results were expressed as mean scores.

7. Statistical Analysis

Data were analyzed using one-way analysis of variance (ANOVA) with STATISTICA software. Differences were considered significant at $p < 0.05$.

RESULTS AND DISCUSSION

1. Results of Physicochemical Analyses

1.1. Raw Materials: Treated Water

The results of physicochemical analyses of treated water are summarized in the table 1 below:

Table 1: Physicochemical Analysis Results of Treated Water

Parameter	Units	Results	P*	Standard *
pH	-	7.23	0.027932	7-8
Chlorides (Cl^-)	mg/l	00	-	$\leq 0.5\text{mg/l}$
Alkalimetric title (ta)	F°	0.00	-	0.00
Complete alkalimetric title (tac)	F°	18.5	0.004090	20-26 F°
Water hardness (th)	F°	17.26	0.004084	12-18 F°

**Internal Standards of COJUNA; *P: Probability of comparing a mean to a standard.

The analyses show that the process water complies with the company's physicochemical standards, which helps

preserve the sensory quality of the finished product and demonstrates the efficiency of the unit's treatment system.

1.2. Orange Pulp

The results of the physicochemical analyses of the orange pulp are presented in the table 2 below:

Table 2: Physicochemical Analysis Results of Orange Pulp

Parameter	Results	P	standard*
pH	1.75	0.022736	1.5-2.0
Brix	46	0.044252	46-50

*Internal Standards of COJUNA

The pH and Brix values comply with the company's internal standards, indicating good extraction and conditioning of the pulp at the

original manufacturer, as well as proper storage conditions.

1.3. Semi-finished Product

The results of the physicochemical analyses of the semi-finished product are summarized in the following table 3:

Table 3: Physicochemical Analysis Results of Semi-finished Product

Parameter	Results	P*	standard*
pH	3.88	0.032547	< 4
Acidity	3.7	0.045887	3.7-4
Brix	12.4	0.044096	11.5-13

The values of pH, acidity, and Brix conform to the company's internal standards, indicating good physicochemical quality of the semi-

finished product, reflecting compliance with dosage requirements.

1.4. Finished and Stored Product

The results of the physicochemical parameters of the finished product and the stored product are summarized in the table 4 below:

Table 4: Evolution of Physicochemical Parameters of Orange Beverage during Ambient Storage

Parameter	T0	T1	T2	T3	T4	standard *
pH	3.096	2.98	3.033	3.04	3.026	2.30-3.80
Brix	11.5	11.5	11.03	11.66	11.36	10.5%-12.5%
Titration acidity	3.52	3.44	3.39	3.39	3.35	3-3.5
Pulp content	12.39	8.05	4.74	4.49	4.12	4%-8%
Vitamin C (mg/l)	233.03	190.7	154.36	88.1	63.83	150mg/l-500mg/l
Color intensity	0.354	0.374	0.387	0.410	0.470	-
Phenolic compounds	0.467	0.451	0.434	0.423	0.393	-
Density	1.051	1.051	1.052	1.053	1.052	-

1.5. pH Evolution

The analyses show that pH remains relatively stable throughout the ambient storage period ($p=0.92782 >0.05$), with variations remaining within the company's standards.

1.6. Brix Evolution

The results indicate that Brix remains relatively stable during ambient storage ($p=0.42565 >0.05$), conforming to the company's standards.

1.7. Titration Acidity Evolution

The analyses reveal a significant difference between the means, with a gradual decrease in titration acidity due to the conversion of organic

acids into volatile acids caused by an increase in storage temperature ($p=0.02407 <0.05$).

1.8. Pulp Content Evolution

Pulp content decreases throughout the storage period, reaching 4.12% ($p=0.00000 <0.05$). This decline is attributed to poor pulp quality.

1.9. Vitamin C Evolution

The results demonstrate a significant reduction in Vitamin C during ambient storage, from 233.03 mg/l to 63.83 mg/l after 4 months ($p=0.00000 <0.05$). This loss is due to the

aerobic degradation of Vitamin C in the presence of residual air in the bottles.

1.10. Color Intensity Assessment

A significant increase in color intensity is observed, rising from 0.354 to 0.470 after four months of storage, likely due to enzymatic browning initiated by glucose, fructose, and ascorbic acid during storage ($p=0.0007 < 0.05$).

1.11. Phenolic Compounds Evolution

The phenolic content decreases during ambient storage, from 0.467 to 0.393 after 4 months, due to oxidative phenomena ($p=0.003 < 0.05$).

1.12. Density Evolution

The analyses show that density remains relatively stable throughout the ambient storage period ($p=0.42122 > 0.05$).

2. Microbiological Analysis Results

2.1. Treated Water

The microbiological analysis of treated water shows the total absence of all tested germs, confirming a satisfactory microbiological and hygienic quality, in accordance with Algerian legislation standards (Official Journal of the Algerian Republic, No. 35, May 1989). The microbiological analysis results of treated water are summarized in the table 5 below:

Table 5: Microbiological Analysis Results of Treated Water

Determination	Result	Standard*
Aerobic mesophilic germs at 37°C	Absence	20
Total coliforms at 37°C	Absence	<10
Fecal coliforms at 44°C/100ml	Absence	Absence
Streptococci at 37°C	Absence	Absence
Clostridium at 46°C	Absence	Absence

*According to the Official Journal of the Algerian Republic No. 35, dated May 1989.

According to JORA No. 35, 1998, the microbiological analysis results of process water show a total absence of all the germs tested for. Based on these results, we can conclude that the water is of satisfactory microbiological and hygienic quality, compliant with the standards set by Algerian legislation, confirming that the water treatment processes are well controlled and managed.

2.2. Orange Pulp

Microbiological analysis of the orange pulp reveals the total absence of mesophilic bacteria, staphylococci, total and fecal coliforms, and yeasts and molds, confirming proper pasteurization and satisfactory microbiological and hygienic quality, compliant with Algerian legislation standards.(Journal Officiel de la

République Algérienne, 1998 -). The microbiological analysis results of orange pulp are summarized in Table 6.

Table 6: Microbiological Analysis Results of Orange Pulp

Determinations	Results	Standard (JORA)
Aerobic mesophilic germs at 30°C	Absence	10 ⁵
Total coliforms at 37°C	Absence	Absence
Fecal coliforms at 44°C/100ml	Absence	Absence
Staphylococcus aureus at 37°C	Absence	Absence
Yeasts at 22°C	Absence	Absence
Molds at 22°C	Absence	Absence

For the interpretation of microbiological analysis results, we referred to the Algerian microbiological standards dictated by the Official Journal of the Algerian Republic No. 35 of May 1998. Based on the results of the analyses performed on the orange pulp, we found a total absence of

mesophilic germs, staphylococci, total and fecal coliforms, yeasts, and molds. This confirms proper pasteurization. We can conclude that the microbiological and hygienic quality of the pulp is satisfactory, meaning it complies with the standards imposed by Algerian legislation

2.3. Finished and Stored Product

Microbiological analyses of the finished product and stored product reveal a total absence of microorganisms during the first

months of storage. However, yeast contamination is observed after two months of storage, likely due to fungal contamination during the manufacturing process or unsanitary conditions (Table 7).

Table 7: Microbiological analysis results of the beverage during storage

Microorganisms Tested	T0	T1	T2	T3	T4	JORA N°35, 1998 Standard
Total aerobic mesophilic organisms	Absence	Absence	Absence	Absence	Absence	2400-17000
Total coliforms	Absence	Absence	Absence	Absence	Absence	Absence
Fecal coliforms	Absence	Absence	Absence	Absence	Absence	Absence
Yeasts/ml	Absence	Absence	20	300	10	<20
Molds/ml	Absence	Absence	Absence	Absence	Absence	<10
Staphylococcus aureus	Absence	Absence	Absence	Absence	Absence	Absence
Clostridium S.R.	Absence	Absence	Absence	Absence	Absence	Absence

Where; T0: Fresh beverage; T1: Beverage stored for 1 month; T2: Beverage stored for 2 months; T3: Beverage stored for 3 months; T4: Beverage stored for 4 months.

Stability Test: The observation of the bottles incubated at a temperature of 30°C for 21 days showed no swelling, which could be caused by gas production from microorganisms or poor packaging quality, and no leakage, which could indicate poor packaging quality. This demonstrates the absence of microbial

forms in the drink and the good quality of the packaging used.

Germ Detection: The microbiological analysis results of the finished product and the products stored for one, two, three, and four months are summarized in the following table.

The results of the microbiological analysis show the absence of harmful microorganisms (including total aerobic mesophiles, coliforms, yeasts, molds, *Staphylococcus aureus*, and *Clostridium*) in both the fresh beverage and the samples stored for up to 4 months. This confirms that the beverage meets the microbiological safety standards set by JORA N°35 (1998) throughout the storage period.

For the interpretation of the microbiological results, we followed the Algerian microbiological standards set by the *Journal Officiel de la République Algérienne* (JORA) N°35, dated May 27, 1998.

Based on the results, there was a complete absence of *Clostridium sulfite-reducers* and *Staphylococcus aureus* throughout the storage period. Regarding total coliforms, the results confirm their total absence, which can be attributed to the effectiveness of the pasteurization process, as coliform bacteria are heat-sensitive. The absence of total coliforms also indicates the absence of fecal coliforms, including *Escherichia coli*, which constitutes 95-99% of fecal coliforms.

a. Interpretation of the microbiological results for fresh orange juice and after 1 month of storage: we observe a complete absence of microorganisms from T0 (fresh beverage) up to 1 month of storage. The titratable acidity of the beverage is high, which likely inhibits the growth of yeasts and molds, whose optimal growth conditions are around pH 5 and 25°C. The low pH of the orange beverage, therefore, helps preserve its hygienic quality. We can conclude that the beverage maintains a high level of microbiological safety, likely due to adherence to proper manufacturing and packaging processes.

b. Interpretation of the microbiological results for orange juice after 2 months of storage at ambient temperature: At this stage,

there is still an absence of all microorganisms except for yeasts, which were found at levels of 1,100 CFU/mL, significantly exceeding the maximum limits set by Algerian standards in 1998. This contamination could be due to fungal contamination during production or unsanitary conditions in the production chain. As a result, cleaning procedures must be more stringent and frequent. While yeasts and molds do not directly spoil the juice from a quality perspective, their presence in large numbers affects the product's organoleptic properties.

c. Interpretation of the microbiological results for orange juice after 3 months of storage at ambient temperature: there is still an absence of total aerobic mesophilic bacteria, which is compliant with Algerian legislation. However, yeast counts reached 1,001 CFU/mL, again exceeding the acceptable limits. This may be explained by contamination during bottling or an insufficient pasteurization process.

d. Interpretation of the microbiological results for orange juice after 4 months of storage at ambient temperature: the beverage contained 4,000 CFU/mL of yeasts, far exceeding the maximum limits imposed by Algerian standards. This significant increase in yeast growth is likely due to improper storage conditions, particularly a lack of cold chain maintenance, which raises concerns about the claim on the product label that the beverage can be safely stored at ambient temperature. Additionally, the presence of total microorganisms in dilutions 10^{-2} and 10^{-3} suggests further contamination. The microbiological quality of the orange juice, particularly for the second, third, and fourth months of storage, is unsatisfactory.

3. Sensory Evaluation Results:

The sensory evaluation results are summarized in the table 8 below, presented as mean scores based on evaluation grids filled out by each taster (Figure 01)

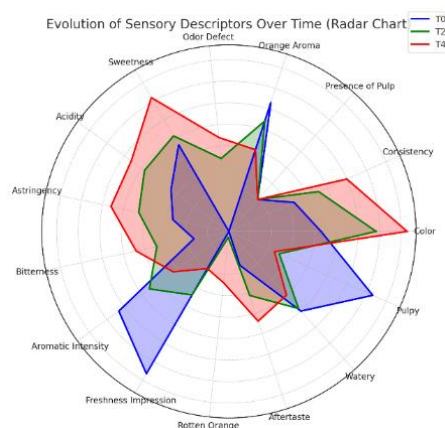


Figure 01: Sensory Analysis of Orange Drink Over Time

Table 8. One-way ANOVA results for sensory attributes of the orange beverage during storage at ambient temperature.

Attribute	p-value	Significance	Effect of Storage Time
Color	0.0206	Significant ($p < 0.05$)	Storage time affects color
Consistency	0.3336	Not significant	Consistency remains stable
Orange Aroma	0.1901	Not significant	Aroma remains stable
Odor Defect	0.0314	Significant ($p < 0.05$)	Storage time influences odor defects
Sweetness	0.2894	Not significant	Sweetness remains stable
Acidity	0.5812	Not significant	Acidity remains stable
Astringency	0.1580	Not significant	Astringency unaffected
Bitterness	0.1279	Not significant	Bitterness remains stable
Aromatic Intensity	0.0302	Significant ($p < 0.05$)	Storage time affects aromatic intensity
Freshness Impression	0.0089	Highly significant ($p < 0.01$)	Storage time strongly affects freshness
Rotten Orange Flavor	0.1253	Not significant	No development of off-flavors
Aftertaste	0.2496	Not significant	Aftertaste remains stable
Watery	0.2019	Not significant	Viscosity remains consistent
Pulpy	0.0025	Highly significant ($p < 0.01$)	Storage time strongly affects pulp content

Color, odor defect, aromatic intensity, freshness, and pulp content are significantly influenced by storage time, whereas other sensory attributes remain stable. These findings

suggest that prolonged storage at ambient temperature may alter certain aspects of the beverage's sensory quality, potentially affecting consumer perception and overall acceptability.

GENERAL DISCUSSION

In this study, we assessed the physicochemical, microbiological, and sensory stability of an orange beverage stored at ambient temperature over a four-month period. Our findings revealed initially satisfactory quality for both raw materials and finished products in terms of microbiological and physicochemical attributes. However, significant deterioration was observed, particularly in sensory descriptors such as color, and microbiological characteristics, as storage time progressed.

Among the sensory descriptors, color plays a crucial role in the perceived quality of food products. Our results show that the color intensity of the orange beverage increased markedly during storage. This change can be attributed to non-enzymatic browning reactions, primarily driven by compounds like glucose, fructose, and ascorbic acid. These reactions, well-documented in recent literature, lead to the formation of brown pigments through the oxidation of phenolic compounds. A similar study (López-Ortiz, et al) highlighted the degradation of phenolic compounds in fruit-based beverages, which contributed to color changes during storage.

Our study revealed a significant correlation between the increase in color intensity and the degradation of phenolic compounds. This had a direct impact on the sensory perception of the beverage, as reported by trained panelists during testing. These results are consistent with those of who demonstrated phenolic compound oxidation can significantly affect the visual quality of orange juice during storage.

In terms of nutritional properties, a substantial decrease in vitamin C content was observed after just four months of storage. The degradation of ascorbic acid is influenced by

several factors, including exposure to oxygen, temperature, and light. Recent studies, such as the one by (Tiwari, BK, et al), confirm that ascorbic acid is highly sensitive to ambient storage conditions, leading to rapid degradation and a loss of nutritional value.

The Principal Component Analysis (PCA) we conducted shows a positive correlation between the degradation of vitamin C and the perceived freshness of the beverage. These results align with findings by (Sapei and Hwa, 2014), which demonstrated that vitamin C serves as a key indicator of the sensory quality of orange-based beverages. The loss of freshness observed could therefore be linked to this degradation, underscoring the importance of maintaining optimal storage conditions.

From a microbiological perspective, our analyses revealed a significant increase in yeast growth from the second month of storage onward. This proliferation is likely due to inadequate storage conditions, particularly the lack of cold chain management. The microbiological instability raises questions about the product label's claim that the beverage can be stored at ambient temperature for six months without compromising safety. A study by (Kakagianni, M et al) indicated that yeast growth in non-refrigerated fruit beverages is common and can rapidly compromise microbiological stability.

In conclusion, our results suggest that the orange beverages produced by COJUNA exhibit unsatisfactory stability and compromised microbiological quality after four months of ambient storage. These findings highlight the need to reassess the storage conditions and shelf-life claims to ensure the quality and safety of the product throughout its intended shelf life.

CONCLUSIONS

In this study, we evaluated the physicochemical, microbiological, and sensory stability of an orange beverage during storage at ambient temperature, from raw material to a four-month storage period. We found satisfactory microbiological and physicochemical quality for both the raw materials and the finished product.

Among the descriptors selected for assessing sensory characteristics, color plays a key role in evaluating food quality. Changes in color can result from defective implementation of the technological process or early spoilage caused by microorganisms. The observed color changes in the beverage during storage are primarily attributed to non-enzymatic browning reactions initiated by glucose, fructose, and ascorbic acid, alongside the oxidation of phenolic compounds that can form brown pigments.

In our case, the increase in color intensity correlated with the degradation of phenolic compounds recorded during ambient storage. This likely impacts the perception of color, as significant variations were reported by

trained panelists. We also noted a substantial decrease in vitamin C after just four months, with several factors potentially influencing the degradation of ascorbic acid.

The Principal Component Analysis (PCA) applied to the physicochemical factors and the perceived freshness showed a positive correlation with the degradation of vitamin C. Indeed, the loss of vitamin C constitutes the main alteration in the orange beverage. Furthermore, monitoring the evolution of microbiological characteristics during storage revealed significant yeast development from the second month onward. This is attributed to inadequate storage conditions concerning the cold chain, raising questions about the claim on the beverage label that it can be stored at ambient temperature for six months without compromising safety.

Our results suggest that orange beverages produced at COJUNA exhibit poor stability and unsatisfactory hygienic quality after four months of storage at ambient temperature, particularly evident from the second month onward

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REFERENCES

- TÉTREAU, J. La mesure de l'acidité des produits volatils. *Journal of the International Institute for Conservation – Canadian Group*, v. 17, p. 17–25, 1992.
- DELACHARLERIE, S.; DE BIOURGE, S.; CHÈNÉ, C.; SINDIC, M.; DEROANNE, C. *HACCP organoleptique: guide pratique*. Gembloux: Presses agronomiques de Gembloux, 2008.
- EL GOZMIR, H.; CHOUHBI, A. Comprendre le comportement du consommateur: perspectives économiques et psychologiques. *Revue Internationale des Sciences de Gestion*, v. 6, n. 4, 2023.
- GUINÉ, R. D. P. F.; BARROCA, M. J. Influence of processing and storage on fruit juices phenolic compounds. *International*

-
- Journal of Medical and Biological Frontiers*, v. 20, n. 1, p. 45, 2014.
- JOURNAL OFFICIEL DE LA RÉPUBLIQUE ALGÉRIENNE. N°35, mai 1989.
 - KAKAGIANNI, M.; KALANTZI, K.; BELETSIOTIS, E.; GHIKAS, D.; LIANOU, A.; KOUTSOUMANIS, K. P. Development and validation of predictive models for the effect of storage temperature and pH on the growth boundaries and kinetics of *Alicyclobacillus acidoterrestris* ATCC 49025 in fruit drinks. *Food Microbiology*, v. 74, p. 40–49, 2018.
 - NF. Norme française NF V03-707. 2000.
 - FAO. *Les bonnes pratiques d'hygiène dans la préparation et la vente des aliments de rue en Afrique: outils pour la formation*. Rome: FAO, 2007.
 - LÓPEZ-ORTIZ, A.; MÉNDEZ-LAGUNAS, L. L.; DELESMA, C.; LONGORIA, A.; ESCOBAR, J.; MUÑIZ, J. Understanding the drying kinetics of phenolic compounds in strawberries: an experimental and density functional theory study. *Innovative Food Science & Emerging Technologies*, v. 60, 102283, 2020.
 - MEKHALFA, S.; KEROUN, S.; BOUBEZARI, M. T. Formulation d'un jus probiotique à base de la carotte et de la betterave. 2022. Thèse (Doctorat) – Université de Jijel.
 - SAPEI, L.; HWA, L. Study on the kinetics of vitamin C degradation in fresh strawberry juices. *Procedia Chemistry*, v. 9, p. 62–68, 201