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Impact Of Drying And Lacto-Fermentation On The Quality Of Tomato Fruits

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Abstract
Background : *The overall objective of this study was to evaluate the effect of several preservation methods on the physicochemical quality of tomato fruits. The experiment focused on two preservation techniques: drying (at 50, 55, and 60°C) and lacto-fermentation. The physicochemical parameters studied were pH, titratable acidity, Brix degree, water content, protein content, and ash content. The results showed that the ideal temperature for drying tomato fruits is 50°C. Indeed, the physicochemical parameters studied showed that at 50°C, the physicochemical characteristics are better preserved than at temperatures of 55 and 60°C. The results obtained after analysis of the lacto-fermented tomatoes showed that lacto-fermentation improves the nutritional value of the food.*
Keywords: *Tomato, preservation, drying kinetics, lacto-fermentation.*

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I. Introduction

The tomato (Solanum lycopersicum) is an annual herbaceous plant of the nightshade family, native to the Andes [1]. It plays an important role in the daily diet thanks to its richness in fiber and minerals.

It is an excellent source of vitamins K, C, B1, E and A (in the form of beta carotene), folate and niacin [2].SheIt also contains various phenolic compounds with strong antioxidant activity. In addition to its nutrients, the tomato contains large amounts of lycopene, which is known for its health benefits.

The tomato is the second most important crop after the potato and is widely cultivated throughout the world. According to the FAO, tomatoes are grown in more than 170 countries. In 2023, global tomato production was estimated at over 190 million tons.

In Africa, the tomato remains undeniably the most consumed condiment. According to FAO statistics, in 2023, tomato production was estimated at 23 million tons, representing 12.02% of global production.

However, a problem arises in its preservation, as it is highly perishable.Due to its high water content and the flexibility of its cell wall, the fresh tomato deteriorates easily, leading to its waste [3]. Once picked, tomatoes are subject to alterations which prevent producers from storing them for more than a few days [1].

Significant post-harvest losses occur throughout the tomato value chain, negatively impacting the incomes of smallholder farmers and traders. Approximately one-quarter of the tomatoes produced are damaged and unusable. Damage can be physical or mechanical, caused by diseases and/or insect infestations, and/or poor shape, etc.

To address the perishable nature of tomatoes, it seems essential to explore methods to mitigate this. Two solutions are therefore conceivable: processing and preservation.

However, preservation techniques can positively or negatively influence food quality. It is with this in mind that this work aims to evaluate the effect of drying and lacto-fermentation on tomato quality.

II. Materials And Methods

Material

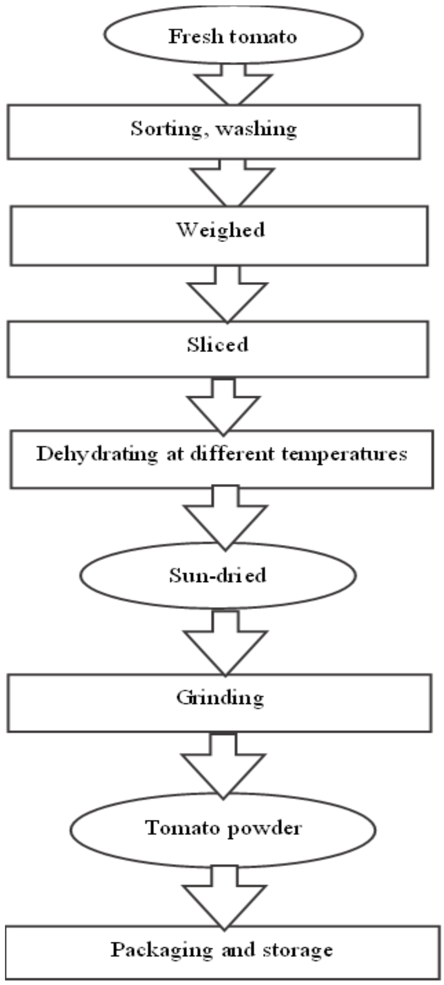
The plant material consists of tomato fruits (*Solanum lycopersicum L*) of the Roma variety purchased at the Tsiémé market (Brazzaville).

Methods

Drying

Figure 1 shows the drying process used to obtain tomato powder.

Lacto-fermentation
The process of obtaining lacto-fermented tomatoes is described in Figure 2.



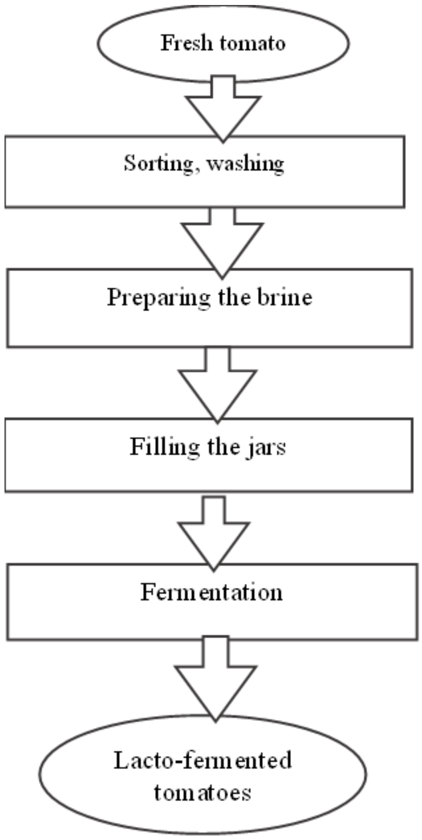


Figure 1 : Diagram of tomato powder production
Figure 2 : Diagram of lacto-fermented tomato production

Calculation of the amount of salt used
To ferment the tomatoes with 3% salt in a 1000ml jar, we proceeded as follows:
$1000\text{ml} \times \frac{3}{100} = 30\text{g}$

Determination of physicochemical parameters
pH
5g of Tomato puree is mixed with 25 ml of distilled water for dried, lacto-fermented, and fresh tomatoes; the mixture is stirred for 15 min followed by filtration. The recovered filtrate was used to determine pH values using a pH meter. [4]

Water content
The determination of water content was carried out according to the AOAC (Official Association of Analytical Chemists) method. [5]

Ash content
The ash content indicates the mineral content of the product. It is determined by method 08-01 (AACC, 1984) [6]. The determination of the crude ash content is based on the principle of separating organic and mineral substances by complete incineration of the sample.

Determination of protein content
The protein content was determined by the total nitrogen assay using the Kjeldahl method.[7]

Determination of Brix

This concentration, measured at 20°C by the refractive index and expressed as a percentage by mass, is measured according to a standardized method using a refractometer.

Determination of titratable acidity

The titratable acidity was determined by titration with a 0.1N NaOH solution in the presence of a colored indicator, phenophthalein.[8]

III. Results And Discussion

Drying

Drying kinetics

Figure 3 shows the drying kinetics graphs of thin-layered tomato slices, defined for various temperatures (60 °C, 55 °C and 50 °C).These curves show two distinct phases, namely:

A decreasing phase going (t=0 to t=420) in which the water loss is rapid, due to evaporation of water in the product following the effects of temperature.

A second constant phase, extending from (t :420 until the end of the final drying time), where this decrease becomes progressively slow until it stabilizes. The stability of the weight can be explained by the fact that the surface temperature has reached that of the drying air.

This same figure shows that temperature has a significant effect on drying time. At 60°C, 555 minutes were sufficient to dry the tomato slices. Whereas at 55°C and 50°C, the drying times were 630 minutes and 780 minutes, respectively. This assertion is supported by some authors [9][10] who have shown that temperature is inversely proportional to drying time.

The reduction in drying time, from 780 minutes at 50°C to 555 minutes at 60°C, could also be due to the temperature/thickness combination.

According to [11], the drying time decreases as the thickness of the tomato slices decreases. Similar results were found by [12].

These results are consistent with those of [13].

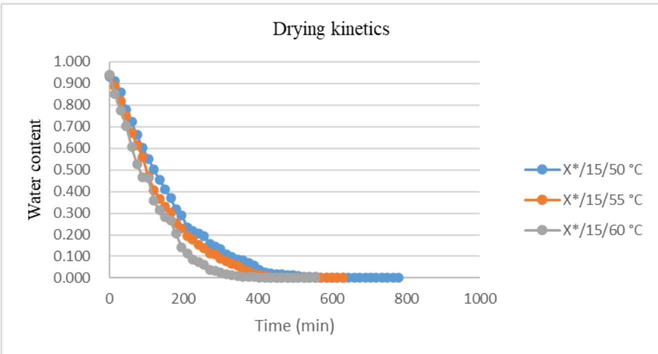


Figure 3 : Drying kinetics of tomato slices

Water content

We observe that the water content (Figure 4) of fresh tomato fruits is higher than that of lacto-fermented tomatoes. Indeed, observation shows that the water content of fresh tomatoes is 94.66 ± 0.04, while the water content of lacto-fermented tomatoes is 93.25 ± 0.33. This finding corresponds to that of [14] and [17], which showed that after immersing tomato fruits in brine, the water content drops from 94.86% to 93.85%.

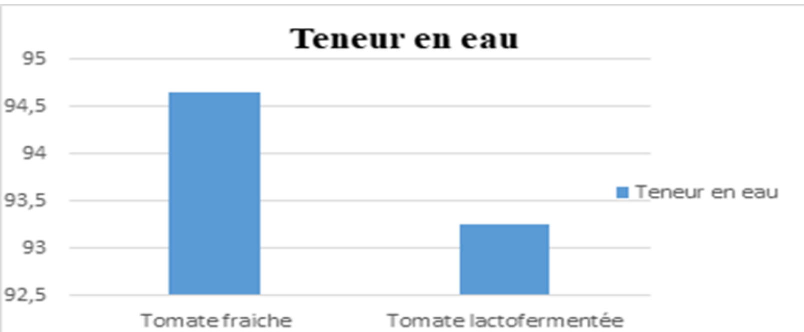


Figure 4 : Water content of tomato fruits

pH

The pH value of fresh tomatoes is higher than that of dried tomatoes (Figure 5). Temperature has an impact on the pH of tomato fruits, with values ranging from 4.15 ± 0.007 for fresh tomatoes to 3.93 ± 0.02, 3.87 ± 0.007, and 3.79 ± 0.007 for dried tomatoes at 50°C, 55°C, and 60°C, respectively. This means that the higher the temperature, the more acidic the product becomes.

The results obtained are similar to those of [4], which demonstrated that temperature has an influence on the pH of dried products.

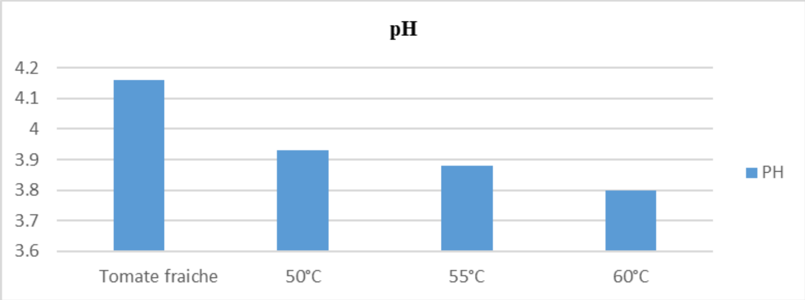


Figure 5 : pH of fresh and dried tomatoes

Brix degree

It can be observed that the sugar content of fresh tomatoes is lower than that of dried tomatoes. Fresh tomatoes have a sugar content of 5.22 ± 0.02, while dried tomatoes have a sugar content of 6.42 ± 0.01 at 50°C; 6.61 ± 0.01 at 55°C; and 6.88 ± 0.005 at 60°C (Figure 6). The higher the temperature, the lower the water content of the product and the higher the sugar concentration.

The results are in agreement with those of the authors [15] who showed that the Brix degree increases after drying.

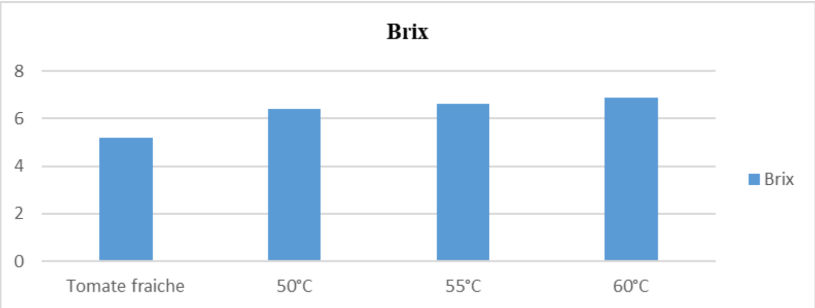


Figure 6 : Brix of fresh and dried tomatoes

Titratable acidity

An increase in titratable acidity is observed after drying, indicating that the drying temperature influences the acidity of tomato fruits. Fresh tomatoes have an acidity of 1.92% ± 0.24, while dried tomatoes have acidities of 3.15%, 3.5%, and 4.2% at 50, 55, and 60°C, respectively.

The titratable acidity at 60°C is higher than that at 55 and 50°C (Figure 7). The results obtained can be compared to those obtained by [15], who showed that the acidity increases after drying.

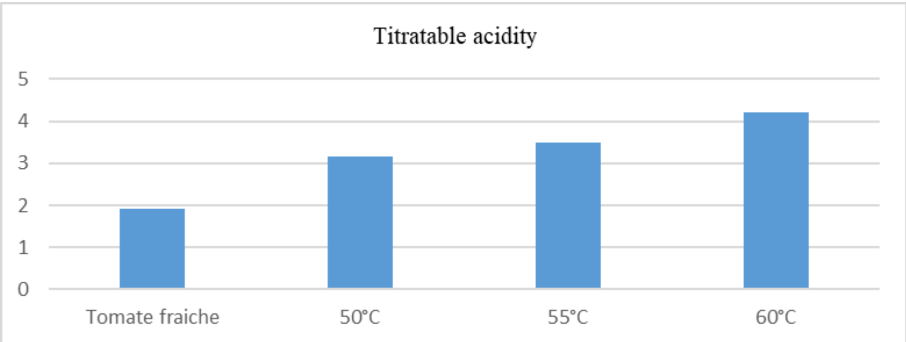


Figure 7 : Titratable acidity of fresh and dried tomatoes

Ash content

The ash content (Figure 8) of fresh tomatoes is low compared to that of dried tomatoes. We also observed that when drying at low temperatures (50°C), the ash content is high, while at medium temperatures (55 and 60°C), the ash content is low. This resulted in values of 1.540 ± 3.47 at 50°C, followed by 1.002 ± 0.013 and 0.87 ± 0.024 at 55 and 60°C, respectively. These results are similar to those of [16] which showed that temperature has an impact on the ash content of tomato powders.

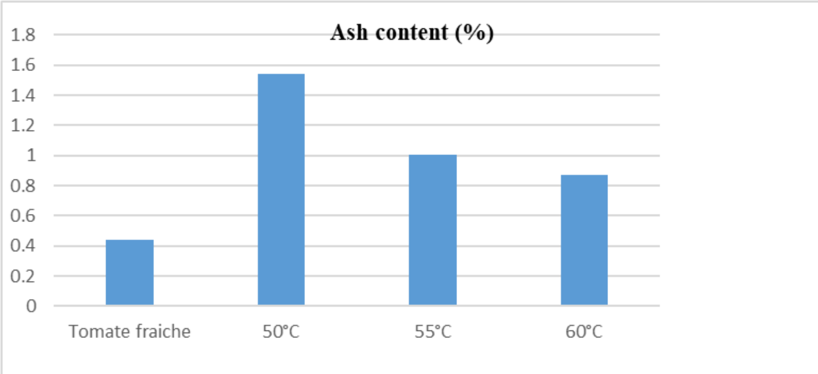


Figure 8 : Ash content of fresh and dried tomatoes

Protein content

The protein content of fresh tomato fruits is higher, at 2.34±0.04, than that of dried tomato fruits (1.61±0.03; 1.48±0.04; 1.46±0.05, respectively at temperatures of 50, 55 and 60°C) shown in Figure 9. This means that temperature can denature the proteins of tomato fruits and reduce their bioavailability.

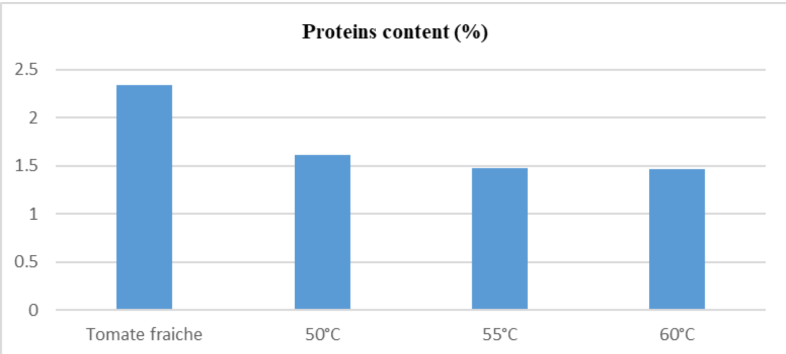


Figure 9 : Protein content of fresh and dried tomatoes

Lacto-fermentation

pH

Analysis of Figure 10 shows that the pH value (4.16 ± 0.007) in the fresh state is higher than that of lacto-fermented tomatoes (2.9 ± 0.07). These results are consistent with those of [18], whose findings showed that lacto-fermentation lowers the pH of tomatoes.

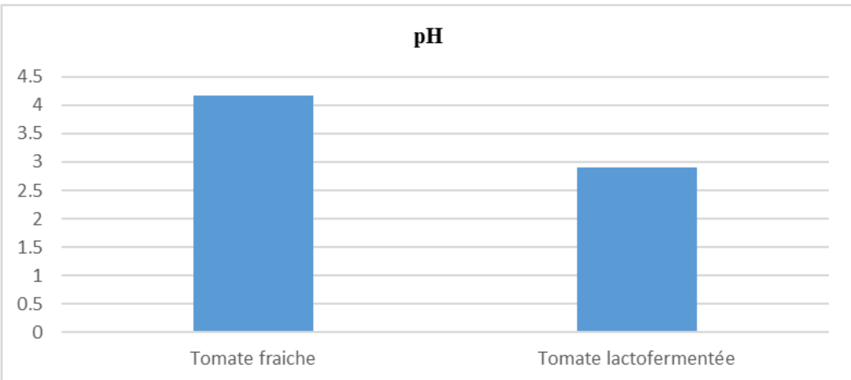


Figure 10 : pH of tomatoes

Degree Brix

Analysis of Figure 11 shows that the sugar content of fresh tomatoes is higher than that of lacto-fermented tomatoes. Fresh tomatoes have a sugar content of 5.22 ± 0.02, while lacto-fermented tomatoes have a sugar content of 5.07 ± 0.005. These results are consistent with the findings of the study conducted by [18].

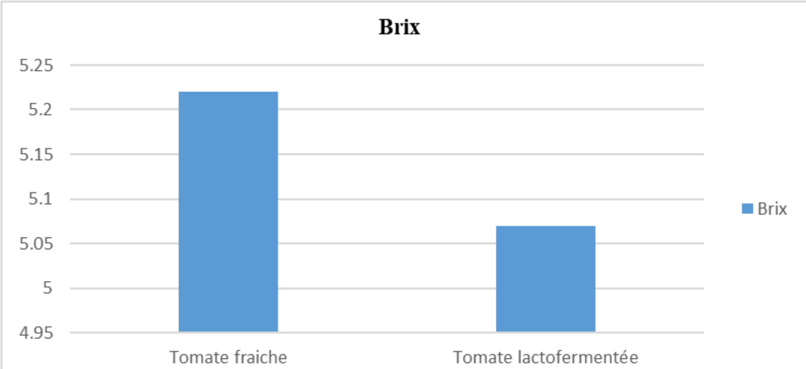


Figure 11 : Brix tomatoes

Titratable acidity

Figure 12 shows that the titratable acidity of lacto-fermented tomato fruits is higher than that of fresh tomato fruits. Indeed, lacto-fermented tomatoes have an acidity of 5.25%, while the acidity of fresh tomatoes is 1.92% ± 0.24. These results are consistent with those of [18].

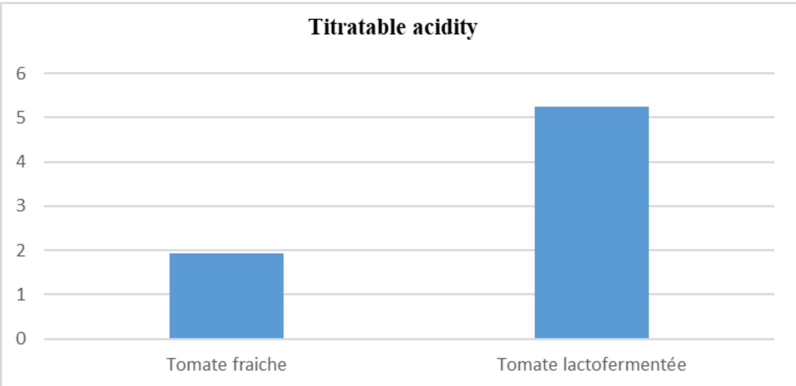


Figure 12 : Titratable acidity of tomatoes

Ash content

Figure 13 shows that the ash content increased during fermentation. Fresh tomatoes have an ash content of 0.44% ± 0.04; after fermentation, this value increases to 1.8% ± 0.05. These results are supported by the authors [18] which showed an increase in ash content after lactofermentation.

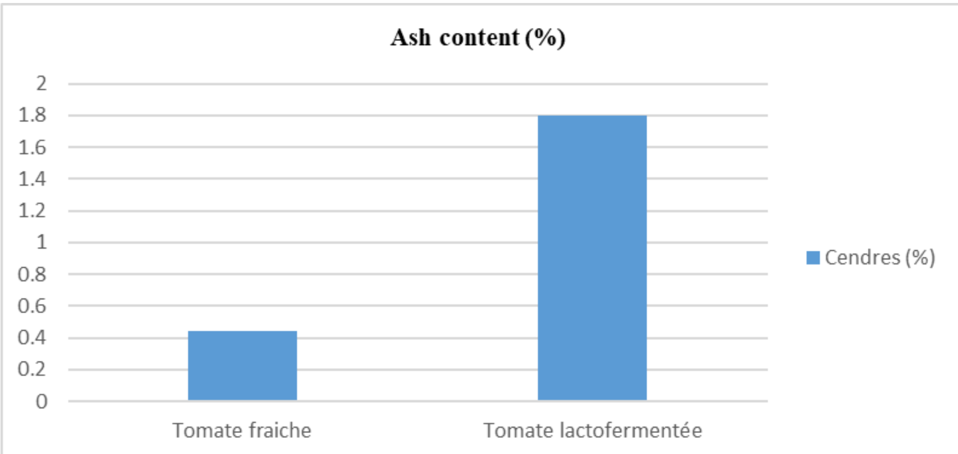


Figure 13 : Ash content of tomatoes

Protein content

We observed that the protein content of lacto-fermented tomatoes increased compared to that of fresh tomatoes (Figure 14). The results of [19] show that fermentation leads to a significant increase in the percentage of protein nutritional value.

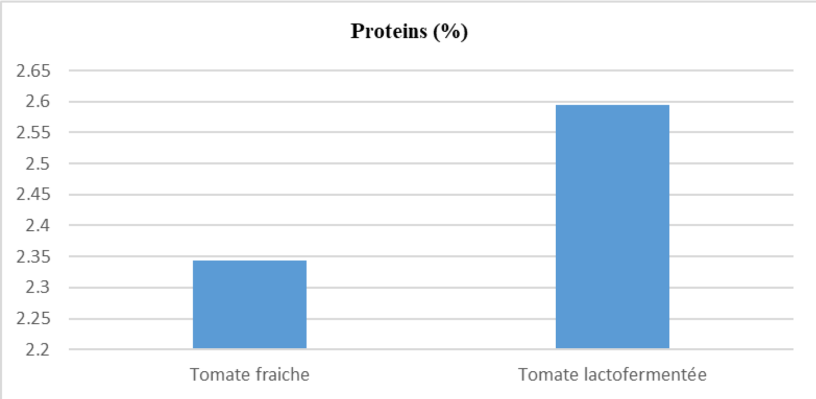


Figure 14 : Protein content of tomatoes

IV. Conclusion

The study focuses on evaluating the physico-chemical changes in tomatoes after the application of these different preservation methods. The ideal temperature for preserving tomato fruits within the studied temperature range is 50°C. Drying concentrates certain substances such as sugar and minerals due to the reduction or evaporation of water during this process, thus increasing their content. Lacto-fermentation, through the action of lactic acid bacteria, increases the content of certain nutrients while lowering the pH of the medium to make it acidic and prevent the proliferation of pathogenic microorganisms.

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