***Original Research Article***

# Assessment of Quality and Production Conditions of Local Beverages Produced in Ouagadougou (Burkina Faso)



.


## ABSTRACT

Artisanal food production has been developing in recent years in African cities. However, the promoters of the artisanal food production structures do not always apply good hygiene practices (GHP) during their activities, which can lead to the production of food of unsatisfactory quality. Thus, this study was initiated to assess the quality and production conditions of local beverages produced in Ouagadougou.Twelve samples of these four beverages (tamarind and pineapple juice, bissap, and toedo) were collected during different productions and then sent to the laboratory. Microbiological and physico-chemical analyzes were done using standard microbiological methods and AOAC methods respectively. The evaluation of the application of GHP was carried out using a checklist. The results obtained show that for all the beverage samples, the pH varies from 2.44±0.02 to 3.55±0.00, The titratable acidity from 0.29±0.02% to 0.75±0.02% and the brix degree from 11.00±0.00% to 16.50±0.11%. TMAF load of and yeast and mold loads were respectively from $1.00x10^3$ CFU/mL to $7.30x10^4$ CFU/mL and from <10 CFU/mL to $9.00x10^2$ CFU/mL. All samples had a coliform load less than 10 CFU/mL.*Salmonella* and *Shigella* were absent in all samples. This study shows that most of beverage samples studied have a compliant pH and Brix level. Referring to all the germs studied, 8.33% of local beverage samples are of satisfactory quality, 41.66% of acceptable quality and 50.00% of unsatisfactory quality. GHP assessment showed compliance rates of 100% (raw material), 66.66% (labour), 66.66% (methods), 55.55% (environment) and 25% (equipment). The results of this study indicate the need for the establishment of a quality assurance system followed within local beverage production structures.


*Keywords: Local beverages, Quality, Microbiology, Physico-chemistry, GHP, Ouagadougou*

## 1. INTRODUCTION

In recent years, there has been a growing demand for drinks made from local products. They are appreciated for their taste, their medicinal virtues and their prices. Thus, the sale of beverages obtained by improved artisanal processes is developing particularly in cities such as Ouagadougou. It enhances the seasonal fruit supply. This promotion concerns other products such as *bissap* flowers and ginger, and also wild products such as tamarind and fruit of Adansonia digitata [1]. Local beverages in general have various advantages for consumers: they are less expensive, more accessible, and ready to drink [2,3]. In addition, various epidemiological studies show that regular consumption of fruit products reduces the risk of chronic disease (diabetes, cancer, asthma, etc.) [4]. Fruit juices are highly nutritious foods for human beings. However, the inability to observe requirements for their preparation, packaging and storage subjects them to microbial contamination which poses a health risk to consumers [5,6]. In addition, the various producers manufacture local beverages and package them in old recovered bottles [3], which can have consequences on the health and market quality of the finished product.

Like any food, local beverages can cause foodborne diseases. Foodborne diseases are an important cause of morbidity and mortality because millions of people fall ill and many die after ingesting food unfit for consumption [7]. These various diseases are related to the consumption of many foods, including beverages sold in collective catering and contaminated by certain bacteria or their toxins. In addition, local drinks can be subject to various alterations that may occur during production, storage and distribution. These alterations result in a deterioration of the organoleptic quality including bad taste, bad smell and change in visual appearance in the product [8, 9]. Thus, the production of poor-quality food results in a loss of competitiveness and money for the food production structures and consumer mistrust [10, 11]. It is therefore essential to support artisanal structures in the production of quality food. Thus, this study was initiated with the aim to evaluate the quality and production conditions of local beverages produced in Ouagadougou.

## 2. MATERIAL AND METHODS

### 2.1 Sampling

Sampling was done in an artisanal beverage production unit. Bottles were sampled in duplicate during three different productions of pineapple juice. The same type of sampling was done for the other local drinks (*Tamarindus indica* juice, *bissap* and *toedo*). Thus, a total of 12 samples including 3 Ananas comosus juice, 3tamarind juice, 3 *toedo* (*Adansonia digitata* fruit powder juice) and 3 *bissaps* (*Hibiscus sabdarifa* flower juice) were collected. These samples were kept in the refrigerator in the laboratory for physico-chemical and microbiological analyses.

### 2.2Physico-Chemical Analyzes

#### 2.2.1 pH

pH was determined using digital pH meter. Thus 25 mL of beverage were introduced into an Erlenmeyer flask, and the pH was measured with a pH meter (HANNA instruments) after dipping the electrodes in the juice. Measurements were made in triplicate for each sample.

#### 2.2.2Titrable Acidity

Titrable acidity was determined by using 10 mL of each beverage sample which were titrated against 0.01 N NaOH using phenolphthalein as indicator. The following formula was used to calculate acidity:

$$\%\mathrm{AT} = \frac{\mathrm{V} * \mathrm{N} * 0{,}07}{\mathrm{VP}} * 100$$

V: Volume of sodium hydroxide (NaOH) solution in ml poured at equivalence; N = normality of sodium hydroxide; VP = volume of beverage taken in ml for titration; 0,07 = conversion factor to citric acid equivalent.

#### 2.2.3Brix Degree

Brix degree of local beverages was determined using a refractometer whereby a drop of beverage was placed on its prism. The percentage of Brix was obtained from direct reading of the refractometer. Brix degree of each sample was read in triplicate.

## 2.3Microbiological Analyzes

### 2.3.1 Preparation of Culture Media

The culture media used during this study (PCA, Sabouraud, EMB, SS, Rappapport-Vassiliadis peptone water) were prepared following the recommendations of the suppliers. These media were sterilized at 121° C for 15 min and then poured into Petri dishes. The SS medium was heated in a water bath (without sterilization) and poured into Petri dishes.

### 2.3.2Samples Dilution

Ten milliliters (10 mL) of each local beverage were mixed with 90 mL of physiological water and homogenized by manual shaking. The liquid phase then forms the stock sample from which dilutions were made to obtain$10^{-1}$, $10^{-2}$, $10^{-3}$ up to $10^{-5}$ dilutions.

### 2.3.3Seeding and Incubation

After mixing each tube with the dilution, 0.1 mL of it was transferred onto a culture medium. The inoculum was spread using a sterile glass rod and the plates were allowed to stay inverted and incubated. The inoculated media were incubated at different temperatures and times (Table 1).The search for *Salmonella and Shigella* was carried out following the steps below:

- Pre-enrichment: 25 mL of each sample were introduced into 225 mL of Buffered Peptone Water and incubated at 37°C for 24 h. This phase allows the revivification of the bacteria;
- Enrichment in selective liquid medium: 1 mL of the pre-enriched broth was introduced into 9 mL of Rappaport-Vassiliadis broth and incubated at 37°C for 24 h;
- *Salmonella-Shigella* isolation: A Pasteur pipette dipped in enrichment medium was used to inoculate *Salmonella-Shigella* agar medium. Dishes were then incubated at 37°C for 24 h.

Table 1. Microorganisms, culture media and incubation conditions.

| Microorganisms | Standard | Culture medium | Incubation condition |
|---|---|---|---|
| TMAF | ISO 4833 [12] | PCA | 37 °C for 24 h |
| TC | AFNOR [13] | EMB | 37 °C for 24 h |
| TTC | AFNOR [13] | EMB | 44 °C for 24h |
| Yeasts and Molds | AFNOR [14] | Sabouraud | 30 °C for 120 h |
| *Salmonella-Sighella* | ISO 6579 [15] | SS Agar | 37 °C for 24 h |

*TMAF: Total mesophilic aerobic flora; TC: Total coliform; CTT: thermotolerant coliforms; PCA: PlateCount Agar; EMB: Eosin Methylene Blue Agar; SS: Salmonella-Sighella*

### 2.3.4Enumeration

The number of microorganisms in CFU/mL of each sample was determined according to standard ISO 7218 [16]:

- For Petri dishes where the number of colonies is between 30 and 300, the numbers of microorganisms were estimated as colony forming unit (CFU/mL) using following equation:

$$N= \frac{\sum \mathbf{C}}{\mathbf{V(n1+0,1n2)d}}$$

N: number of microorganisms in CFU/mL of product; ∑C: sum of colonies; V: volume of inoculum inoculated in each dish in mL; n1: number of plates for the first dilution retained; n2: number of plates for the second dilution retained; d: lowest dilution rate retained

- For plates with a sum of colonies less than 15, the following formula was used:$N= \frac{\sum C}{V*d}$

- For the dishes in which no colony was observed, the number of microorganism was considered to be less than 1/d (N< 1 / d).

### 2.4GHP Assessment

The evaluation of the application of good hygiene practices at the local beverage production site was made according to the recommendations *of Agence Canadienne d'Inspection des Aliments* (ACIA, 2005). The compliance rates of the different levels of GHP (Environment, Raw Material, Workforce, Method and Equipment) were calculated for each of the GHP level according to following formula:

$$\boldsymbol{Compliance\ rate} = \frac{\boldsymbol{C}}{(\boldsymbol{C} + \boldsymbol{NC})}$$

C: number of compliant criteria;NC: number of non-compliant criteria;(C+NC): number of applicable criteria.

### 2.5Statistical Analyzes

The data collected during this study was subjected to an analysis of variance using XLSTAT 2019 version 2.2.59614 Software. Mean variables were compared using the Newman Keuls' test at probability level p = 0.05.

## 3. RESULTS AND DISCUSSION

### 3.1 Physicochemical Characteristics

The results obtained for all the physicochemical characteristics of all the local beverages samples are presented in Table 2.



**Table 2. Physico-chemical characteristics of local beverages**

| Beverage | Sample | pH | Brix (%) | Titrable acidity (%) |
|---|---|---|---|---|
| *Ananas* | Ea1 | 3.36±0.00 | 13.20±0.10 | 0.55±0.00 |
| | Ea2 | 3.54±0.00 | 12.00±0.00 | 0.51±0.03 |
| | Ea3 | 3.55±0.00 | 11.00±0.00 | 0.50±0.00 |
| *Toedo* | Et1 | 3.50±0.01 | 15.00±0.34 | 0.43±0.02 |
| | Et2 | 3.20±0.00 | 16.40±0.50 | 0.38±0.01 |
| | Et3 | 3.06±0.10 | 16.00±0.17 | 0.44±0.03 |
| *Tamarin* | Eta1 | 2.70±0.10 | 14.33±0.23 | 0.53±0.07 |
| | Eta2 | 2.95±0.03 | 15.53±0.23 | 0.37±0.24 |
| | Eta3 | 3.04±0.01 | 16.00±0.00 | 0.56±0.01 |
| *Bissap* | Eb1 | 2.44±0.00 | 16.40±0.20 | 0.49±0.04 |
| | Eb2 | 2.73±0.01 | 16.40±0.20 | 0.29±0.02 |
| | Eb3 | 2.49±0.01 | 16.50±0.11 | 0.75±0.02 |

#### 3.1.1pH

pH of the pineapple juice samples analyzed ranged from 3.36±0.00 to 3.55±0.00 with an average of 3.54±0.00. For toedo, the pH varies between 3.06±0.10 and 3.50±0.01 with an average value of 3.20±0.05. In the *bissap* samples, the pH ranged from 2.44±0.00 to 2.73±0.01 with an average of 2.55±0.01. For Tamarind juice, the average pH is 2.89±0.04 with minimum and maximums values of 2.70±0.10 and 3.04±0.01 respectively. These results show that, in general, the beverages studied have relatively low pH and are compliant because they are within the limit (2 < pH < 4) indicated for fruit juices [17]. Statistical analysis shows that there is a significant difference between the pH values of different beverages (p=0.001). Other authors have reported similar results to those of this study. Thus, Kouassi et al. [18] found an average pH of 3.29±0.11 in the *tomi* (an artisanal drink made from Tamarindus indica pulp). Similarly, Ouattara et al. [3] showed that the pH values obtained from the *bissap* juices they studied were between 2.56 and 2.72. Authors also found relatively different pH values than in this study. Thus, Kouassi et al. [18] reported an average pH of around 2.84±0.14 in *toedo* while Reddi et al. [19] found pH ranging from 4.00 to 4.04 in pineapple juice.

#### 3.1.2Titrable Acidity

For all the samples of local beverages studied, the acidity varies from 0.29±0.02% to 0.75±0.02% with averages of 0.52±0.01%, 0.41±0.01%, 0.48±0.24 and 0.51±0.03 respectively for pineapple juice, *teodo, bissap* and tamarind juice (Table 2). The analysis of variance shows that there are no significant differences between the titrable acidity of the different beverages (p=0.758). Highly variable levels of titrable acidity in fruit juices have been noted in other studies. Thus, according to Khanam et al. [20], the concentration of acidity of fruits juices ranged between 0.16% and 0.39%. In addition, titrable acidity concentrations ranging from 0.53±0.010% to 0.67±0.010% have been found in cashew apple juices [21]. It should also be noted that Kouassi et al. [18] and Yao et al. [17] reported titrable acidity concentrations of 159.24±0.20 meq.g/L in *teodo* and 384.4 to 841 meq.g/L in *tomi*.

#### 3.1.3Brix Degree

For this parameter, the results of the study show heterogeneous values ranging from 11.00±0.00% to 16.50±0.11%. For each type of local beverage, the mean Brix values were 12.06±0.05%, 15.80±0.16%, 16.43±0.17%, and 15.28±0.15 % respectively for pineapple juice, *teodo, bissap* and tamarind juice. This study shows relatively high Brix values in *Toedo, bissap* and pineapple juice. This observation is confirmed by the analysis of variance which shows that there is a significant difference between the Brix degrees of pineapple juice and those of other beverages (p=0.001). The Brix values obtained for these three types of local beverages are higher than those reported by Khanam et al. [20] who found that total soluble solids were ranged from 12% to 13% and overall mean concentration of total soluble solids of bottled juices was 12.33±0.58. Total Soluble Solid is one of the most important quality factors for most of fruit juices and it is influenced by the combined effect of stages of maturity and ripening conditions [22]. According to CODEX STAN 247 [23], The sugar content (soluble dry extract) of tamarind juice samples must be at least of 13%. With reference to this standard, most of the samples of local beverages studied are compliant for this parameter (except two samples of pineapple juice).

### 3.2Microbiological Characteristics

The microbiological characteristics of local beverage samples are presented in Table 3. The results obtained show that globally, the different samples are contaminated by Total mesophilic aerobic flora (TMAF) and yeasts and molds. However, these samples are free of coliforms and *salmonella* and *shigella* (Table 3).

**Table 3. Microbiological characteristics of local beverages**

| Beverage | Sample | TMAF (CFU/mL) | TC (CFU/mL) | CTT (CFU/mL) | YM (CFU/mL) | SS (in 25 mL) | Appreciation |
|---|---|---|---|---|---|---|---|
| | Ea1 | $9.27x10^3$ | < 10 | <10 | $9.00x10^2$ | ND | Acceptable |
| *Ananas* | Ea2 | $5.09x10^3$ | < 10 | <10 | $2.00x10^2$ | ND | Acceptable |
| | Ea3 | $4.27x10^3$ | < 10 | <10 | $3.00x10^2$ | ND | Acceptable |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Toedo* | Et1 | $1.60 \times 10^4$ | < 10 | <10 | $4.00 \times 10^2$ | ND | Non-compliant |
| | Et2 | $3.81 \times 10^3$ | < 10 | <10 | $1.80 \times 10^2$ | ND | Acceptable |
| | Et3 | $3.00 \times 10^4$ | < 10 | <10 | $3.10 \times 10^2$ | ND | Non-compliant |
| *Tamarin* | Eta1 | $7.36 \times 10^4$ | < 10 | <10 | <10 | ND | Non satisfaisant |
| | Eta2 | $1.25 \times 10^3$ | < 10 | <10 | <10 | ND | Compliant |
| | Eta3 | $1.00 \times 10^5$ | < 10 | <10 | $2.00 \times 10^2$ | ND | Non-compliant |
| *Bissaps* | Eb1 | $4.27 \times 10^4$ | < 10 | <10 | $2.00 \times 10^2$ | ND | Non-compliant |
| | Eb2 | $1.27 \times 10^4$ | < 10 | <10 | $3.00 \times 10^2$ | ND | Non-compliant |
| | Eb3 | 7.36x103 | < 10 | <10 | $1.00 \times 10^2$ | ND | Acceptable |
| Normes | | $5 \times 10^3$-$10^{4*}$ | $5$-$10^{2*}$ | $5$-$10^{2*}$ | $10^2$-$10^{3*}$ | Absent/25 mL* | |

**: Gulf Standards* [24]*;ND: Not detected; TMAF: Total Mesophilic Aerobic Flora; TC: Total Coliform; TTC: Thermotolerant Coliforms; YM: Yeasts and Molds; SS: Salmonella-Shigella*

### 3.2.1 Total Mesophilic Aerobic Flora

This study shows that all samples of local beverages are contaminated with TMAF with relatively high loads. The TMAF load varies from $1.25 \times 10^3$ CFU/mL to $1.00 \times 10^5$ CFU/mL. The analysis of variance shows that there is no significant difference between the TMAF of the different beverages (p=0.199). Referring to Gulf Standards [24], 50% of local beverage samples are of unsatisfactory quality, 25% are of acceptable quality and 25% of satisfactory quality. None of the pineapple juice samples were of unsatisfactory quality. The TMAF loads obtained during this study are similar to those reported by Nma and Ola [25] which ranged from $3.0 \times 10^2$ CFU/mL to $9.0 \times 10^4$ CFU/mL for pineapple juice in Nigeria. However, they are higher than those reported by Yao et al. [17] which showed load of TAMF ranged from $9.9 \times 10^2$ CFU/mL to $2.7 \times 10^3$ CFU/mL and lower than those found by Khanam et al. [20]. These last authors reported mean values of total bacteria count ranged from $4.63 \times 10^5$ CFU/mL to $5.6 \times 10^7$ CFU/mL. TMAF loads obtained in beverages used in this study are particularly high for foods with low pH and having undergone heat treatment. The significant presence of these microbes could result from insufficient heat treatment or recontamination after treatment. These hypotheses are supported for observations of Kader et al. [26]. According to these authors, contamination of beverages could also be occurred due to lacking of proper quality control system for juice preparation, lacking of right storage conditions and bad packaging system.

### 3.2.2Yeasts and Molds

Most of samples studied contain yeasts and molds at fairly high loads. Only two samples of tamarind juice did not contain this type of microorganisms. Yeast and mold loads ranged from <10 to $4.00 \times 10^2$ CFU/mL. The analysis of variance shows that there is no significant difference between the yeast and mold loads of the different beverages (p=0.215). According to Gulf Standards [24], 16.66% of the samples are of satisfactory quality and 83.33% of acceptable quality. The two samples of satisfactory quality concern tamarind juice. Other authors have reported similar yeast and mold loads to those of this study. Thus, Yeast and mold loads ranged from $1.5 \times 10^3$ CFU/mL to $6.3 \times 10^3$ CFU/mL in tamarind juice and from $10^2$ CFU/mL to $2.2 \times 10^2$ CFU/mL in pineapple juice were reported by Yao et al. [17], Nma and Ola [25]. However, according to Rachedi et al. [27], no yeast or mold was counted in pasteurized fruit juices. In contrast, High value of total fungal count ranging from $8.2 \times 10^5$ CFU/mL to $1.6 \times 10^7$ CFU/mL were found in fruit juice [20]. Most of the local beverage samples in this study are contaminated with yeasts and molds. The presence of these microorganisms in artisanal beverages is corroborated by Ndiaye [28] who showed that yeasts and molds can grow normally in this type of food.

### 3.2.3 Total and Thermotolerant Coliforms

Total and thermotolerant coliforms were not detected in any of the local beverage samples (Table 3). The local beverages studied are therefore of satisfactory quality for this type of microorganism according to Gulf Standards[24]. The absence of coliforms in local beverages has been reported by other authors[3,17,25]. However, other authors have indicated the presence of coliforms in pineapple juices and *bissap* in Benin [6].

#### 3.2.3 *Salmonella* and *Shigella*

*Salmonella* and *Shigella* were absent from all local beverage studied. For this type of microorganism also, all the beverage samples are of satisfactory quality according to Gulf Standards [24]. The results of this study are similar to those of Mouloudi [29] who also reported an absence of *Salmonella* in their beverage samples. However, Komagbe et al. [6] noted the presence of *Salmonella* in a sample of pineapple juice. Similarly, the presence of *Salmonella* and *Shigella* was reported by Ouattara et al. [3] in *bissap* samples in Côte d'Ivoire and by Ahoyo al. [30]. Taking into account all microorganisms counted or searched during this study, only 8.33% of the samples of local beverages are of satisfactory quality. About 41.66% and 50.00% of the samples are of acceptable or unsatisfactory quality respectively. These results could be explained by an insufficient application of GHP during the production of beverages.

### 3.3Application of GHP

GHP assessment showed compliance rates of 100% at raw material level, 66.66% for Workforce, 66.66% at method level, 55.55% at Environment level and 25% for equipment (Figure 1). Taking into account all the 5 levels of HP application, an overall compliance rate of: 64.28% was obtain. Cases of non-compliance include: lack of sinks, lack of functional toilets, work floor always covered with dust (Environment), utensils not made of stainless steel, unsuitable heat treatment device (Equipment), personnel without regular medical examination and often wearing jewelry while working (Labour), failure to respect the forward march and absence of a disinfection plan (Method). These breaches of basic hygiene rules could explain the significant presence of TMAF and yeasts and molds in the beverage samples used in this study. Other authors have also linked contamination of beverage samples to non-compliance with GHP. Thus, according to Nma and Ola [25], different bacterial and fungal species occur within fruits and materials used for the production of juice as well as poor sanitation, extraction, raw material contaminations (often from insect damage), lack of both proper heat sterilization and adequate quality control during processing of fruit juice. Simalarly, according to Mahale et al. [31], improper washing of fruits adds these bacteria to juices leading to contamination.

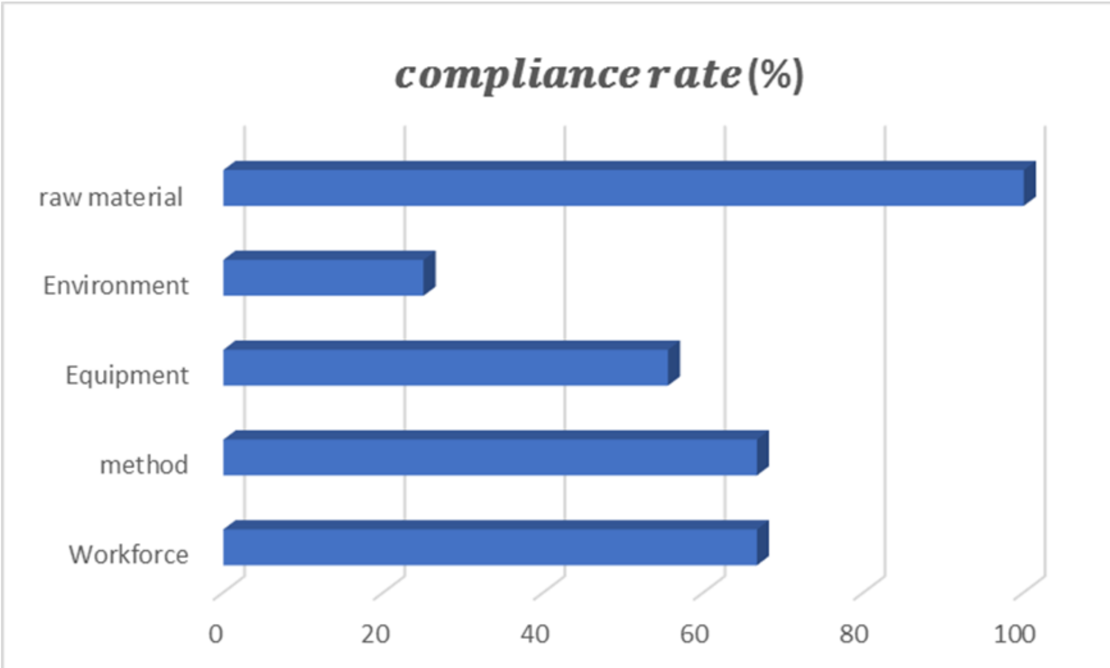


**Fig. 1.Compliance Rates of different levels of GHP**

## 4. CONCLUSION

The results obtained during this study show that most of the beverage samples present physico-chemical characteristics in accordance with the recommendations. However, at the microbiological level, 50% of the beverage samples are of unsatisfactory quality. The non-compliance of these samples is essentially linked to the presence of TMAF and yeasts and molds because coliforms, salmonella and shigella were not detected in the beverages used in this study. The study also reveals a low application of GHP during the production of beverages with an overall compliance rate of 64.28%. In view of all the results obtained during this study, it would be interesting to ensure the application of GHP to reduce contamination as much as possible in local beverages production structures. In addition, it would be useful to set up a quality assurance system followed within these production structures.



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