Microbiological Criteria and Quality of Fruits and Fruit Juices in Ethiopia and International Experience

Hylemariam Mihiretie1,2* and Kassu Desta1

1Department of Medical Laboratory Sciences, College of Medical and Health Sciences, Wollega University, Nekemte, Ethiopia
2Department of Medical Laboratory Sciences, College of Medical and Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia

Abstract

The consumption of fruits and fruit juices could have both positive and negative effect on the part of consumers. Fruits and fruit juices processed under hygienic condition could play important role in enhancing consumers’ health through inhibition of breast cancer, congestive heart failure (CHF), and urinary tract infection. In absence of good manufacturing practice; however, the nutritional richness of fruits and fruit juices makes the product good medium for microbial growth, vehicle of foodborne pathogens and associated complications. Although scanty on Ethiopian side, some countries of the world have set standards for the maximum permissible level of microbes in fruits, fruit juices and related products. The quality of fruits and juices is strictly maintained in developed countries under some law and regulation but in many developing countries where Ethiopia is not an exception; the manufacturer is not concerned about the microbiological safety and hygiene of fruits and juices because of negligence of law.

Keywords: Microbiological quality; Microbiological criteria; Fruits; Fruit juices

Background

Fruits and fruit juices are common beverages in many countries of the world. In hot climate areas, cafés, restaurants and road side stalls have local facilities to extract the juice from fresh fruits and then serving the juice liberally dozed with ice, to the thirsty customers [1].

The consumption of fruits and fruit juices could have both positive and negative effect on the part of consumers. Fruits and fruit juices processed under hygienic condition could play important role in enhancing consumers’ health through inhibition of breast cancer, congestive heart failure (CHF), and urinary tract infection. In absence of good manufacturing practice; however, the nutritional richness of fruits and fruit juices makes the product good medium for microbial growth, vehicle of foodborne pathogens and associated complications [2].

Fruits and juices contaminated at any point of processing could be the source of infectious pathogens. Study conducted on the microbiological safety of some fruit juices showed high prevalence of Salmonella in apple and orange juices. E. coli O157:H7 infection has been linked with consumption of apple juices. The prominent pathogens involved in unpasteurized juice outbreaks have been identified as E. coli O157:H7, Salmonella species and Cryptosporidium [3].

In recent years the increasing consumer awareness has emphasized the need for microbiologically safe food. Since the human food supply consists basically of animal and plant products, it is undesirable that our food supply can contain microorganisms in interaction with the food. When the microorganisms involved are pathogenic, their association with our food is critical from a public health point of view. Serious health hazards due to presence of pathogenic microbes in food can lead to food poisoning outbreaks [4].

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Microbiological Quality and Criteria Related Issues

Worldwide, health concern has led to the popularization of natural fruit and fruit juice as a healthy alternative to other beverages. Fruits and fruit juices are nutritious which offer great taste and health benefits. The spoilage of food is most after due to contamination with aerobic acid-tolerant bacteria as well as yeasts and molds. Thus, enumeration of these microorganisms is an important aspect of evaluating the microbiology quality of acidic foods [4].

Most countries now have food regulations and enforcement mechanisms that prevent bacterial contamination of fruits and juices. Despite these efforts, another serious safety problem associated with fruits and juice consumption has arisen. Contaminations of fruits and juices with pathogenic microorganisms such as E. coli O157 H7 and salmonella have caused numerous illnesses and some fatalities. All reported cases of contamination by pathogenic microorganisms were due to fresh, unpasteurized juices and fruits. This is an increasingly popular segment of the juice industry, whose sales are now jeopardized by new regulations [5].

Microorganisms form part of the epiphytic flora of fruits and juices. This means that they grow on plants but are not parasitic to them, and thus many will be present at the time of consumption. The numbers of bacteria present will vary depending on seasonal and climatic variation thus many will be present at the time of consumption. The numbers of bacteria present will vary depending on seasonal and climatic variation because of negligence of law.

*Corresponding author: Hylemariam Mihiretie, Department of Medical Laboratory Sciences, College of Medical and Health Sciences, Wollega University, Nekemte, Addis Ababa University, Addis Ababa, Ethiopia, Tel: 251 576 617 981; E-mail: hylemariam@gmail.com

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Microbiological Criteria

An important current trend is toward the use of procedures that deliver fruit and juice products are less “heavily” preserved, higher in quality, perceived as being more “natural”, contain fewer additives, and are nutritionally healthier. Some new and “emerging” techniques aim to meet some of these objectives [7]. Microbiological criteria are intended to give some degree of assurance that food is safe and of suitable quality, and that it will remain so to the end of its shelf life provided it is handled appropriately. The EC Regulation on Microbiological Criteria for Foodstuffs requires Food Business Operators (FBO) to use the criteria given in the Regulation when carrying out validation and verification checks as part of food safety management systems based on Hazard Analysis and Critical Control Point (HACCP) principles [8].

Microbiological criteria must indicate the food and stage of processing to which they relate. Ideally, they should give a description of the food, indicating key processing features and conditions under which the material should be stored and used. Such factors significantly influence the content and validity of a microbiological criterion. For example, a specification for frozen food may allow higher aerobic plate counts at the point of production compared with the same chilled food since bacteria will not grow under frozen conditions but may grow during chilled storage. A microbiological criterion consists of a statement of at least the following: the microorganism or microbial toxin of concern, the food concerned and sample type, the sampling plan and the microbiological limit(s) [9].

In regulation EC/2073/2005 microbiological criteria are divided into two types namely: Food safety criteria – dealing with the presence of micro-organisms in the food, that represent a risk to human health, and Process hygiene criteria – dealing with microorganisms that can be used as indicators of the level of hygiene present in the food business. For Salmonella, as an important human pathogen, where five samples of 25g each are taken none of the samples will contain detectable levels of Salmonella is acceptable. For E. coli as an indicator of process hygiene the following apply: Satisfactory if all values observed are less than 100 CFU/g, acceptable if a maximum of microbes are between 100 and 1000 CFU/g and the rest of the values are less than 100 CFU/g, unsatisfactory if one or more values observed are greater than 1000 CFU/g or more [10].

According to EC/2073/2005, the microbiological criteria of fresh fruits and juices include; regular testing against the criterion is not useful in normal circumstances for fresh, uncut and unprocessed vegetables and fruits, excluding sprouted seeds, Escherichia coli and Salmonella tests for pre-cut fruit and vegetables (ready-to-eat) and unpasteurized fruit and juices should be performed, Salmonella tests for sprouted seeds [11].

Microbiological Quality

The quality of fruits and juices is strictly maintained in developed countries under some law and regulation but in many developing countries where Ethiopia is not an exception; the manufacturer is not concerned about the microbiological safety and hygiene of fruits and juices because of negligence of law. Thus the transmission of some human diseases through juice and other drinks are considered a serious problem in recent years [12].

(These are test data, not actual content.)


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In accordance with the official legislation (“Službeni glasnik RS”, 27/10) 20 mg/kg is allowed limits for 5-HMF in apple juice. The International Federation of Fruit Juice Processors (IFFJP) has recommended maximum concentrations of 5-10 mg/l and 25 mg/kg in fruit juices and concentrates, respectively (Wagner, 2006); and the European Union has set a limit of 20 mg/kg 5-HMF for juices made for children (FPA, 2006).

According to the U.S Food and Drug Administration, fruit and juice supply requires a comprehensive and coordinated effort throughout the fruit and juice production and transportation system. The responsibility to safeguard the fruit and juice supply is shared by everyone involved, from the grower to the consumer. This includes growers, farm workers, packers, shippers, transporters, importers, wholesalers, retailers, government agencies, and consumers. Analyzing the risk of microbial contamination includes a review of five major areas of concern. These involve: 1) water quality, 2) manure/municipal bio solids, 3) worker hygiene, 4) field, facility, and transport sanitation, and 5) trace back. Growers, processors, packers, and shippers should consider the variety of physical characteristics of produce and practices that affect the potential sources of microbial contamination associated with their operation, and decide on which combination of good agricultural and management practices are most cost effective [17].

The FDA also gives directions to reject fruits and juices which are not compatible with labeling requirements, spoiled, with prohibited additives, non-compliance with requirements of the U.S. low acid canned food regulations, heavy metal contamination, excessive levels of pesticide residues, and excessive levels of mycotoxin, mold infestation and microbiological contamination [18].

According to Ethiopian Public Health Institute (EPHI) food microbiology guideline, no person shall sell or consume fruits or juices that; is assumed to have any poisonous or harmful substance, unfit for human consumption, consists in whole or in part of any filthy, putrid, disgusting, rotten, decomposed or diseased fruits, spoiled, manufactured, prepared, preserved, packaged or stored under unsanitary conditions. Further no person shall manufacture, prepare, preserve, package or store for sale any fruit or fruit juices under unsanitary conditions [19].

**Laboratory Aspects**

Different parameters can be undertaken to evaluate the safety level of fruits and fruit juices [20]. Most probable number tests, microscopic examination, colony characteristics and rapid biochemical tests are some of the tests [21,22]. Microscopic investigation for Gram reaction and morphological features of suspected colony is also an important technique for screening the Gram reaction of bacteria [23,24].

Other tests like total viable count using serial dilution and total coliform count can also be performed. In total viable count serial decimal dilutions of each sample are made using peptone water solution as diluent. As a guide, with clean products dilution to $10^3$ may be sufficient whereas heavily contaminated products may require dilution to $10^4$ [21].

**Conclusion**

Several pathogenic bacteria, fungi and parasites capable of causing human disease can be found on raw fruits and fruit juices. Some of these microorganisms are capable of growing on whole, minimally processed or cut fruits and juices under routine handling and storage conditions. Differences in surface characteristics of fruits and juices, type and physiological state of microbial cells, and environmental stress conditions interact to influence the activity of disinfectants and sanitizers. Generally speaking, there are not microbiological standards and regulations which apply for the criteria and quality of fruits and fruit juices in Ethiopia and fruits and juices are sold in street market and supermarkets and no safe handling, processing and feeding except washing with water. Therefore there should be continual training and inspection of fruit growers and juice handlers at all levels in order to control microbiological hazards that may be influenced by current and changing aquaculture, agronomic, processing, distribution and preparation practices (Table 1).

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**Conflict of Interest**

The authors declare that they do not have conflict regarding the publication of this review.

**References**


**Table 1:** Summary of experiences from various researches on microbiological aspects of fruits and fruit juices.

<table>
<thead>
<tr>
<th>Country</th>
<th>Year of publication</th>
<th>Authors</th>
<th>Reference number</th>
<th>Major findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>2009</td>
<td>Tamberker et al.</td>
<td>[20]</td>
<td>Fruit and juice related outbreaks of gastroenteritis caused by pathogenic E. coli, Salmonella and Shigella are common</td>
</tr>
<tr>
<td>Nigeria</td>
<td>2012</td>
<td>Oranusi et al.</td>
<td>[21]</td>
<td>Apple fruits are popularly displayed completely exposed for sales in shopping malls and fruits are often purchased as ready to eat and thus usually consumed without washing which results in disease</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>2008</td>
<td>Kelma et al.</td>
<td>[22]</td>
<td>Fruit juices are available in supermarkets in canned or bottled forms. Papaya and avocado juices had initial pH values of &gt;5.7 and allowed all test strains to reach numbers &gt;10^5 cfu/ml at ambient temperature holding Orange juice (pH 3.1) did not allow the survival or growth of the test organisms at both holding temperatures</td>
</tr>
<tr>
<td>Ethiopia (Hawassa)</td>
<td>2011</td>
<td>Worku</td>
<td>[23]</td>
<td>Samples were positive for thermo tolerant E. coli and shown to contain Salmonella species. Moreover, all vendors obtained fruit from the open market and only one vendor stored fruits in refrigerator which indicates there is no standard microbiological criteria and quality of fruits and fruit juices in Ethiopia</td>
</tr>
</tbody>
</table>
18. (2000) HACCP, Quality Control/Quality Assurance and International Trade; Good Manufaturig,P.G Practices (Gmp), Hygiene Requirements