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Mini Review

Evaluation of microbiological criteria and quality of packed fruit juices

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Abstract

The packed fruit juices play an important role in fulfilling nutritional requirements of consumers at affordable prices. The composition of these juices is based on standard requirements of the consumers; the integrity of composition depends upon the storage and freezing conditions. 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 e.g. 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. Recently, fruits as well as fruit juices have been acknowledged as "emerging vehicles" for foodborne illnesses due to bacterial pathogens, protozoa and viruses. In this paper we aim to review precise sources of microbial contamination and most relevant outbreaks involving foodborne pathogens and spoilage microorganisms associated with fruit juices.

Introduction

Fruit juices are an important source of bioactive compounds. These are nutritious drinks with great taste and health benefits (Suaad and Eman, 2008). Juice may be prepared in home from fresh fruits and vegetables using hand or electric juicers or may be marketed in concentrate form, requiring addition of water to constitute it to its "original state" (Doyle, 1991). However, concentrates have a noticeable different taste than "fresh squeezed" versions. Other juices are reconstituted before packaging for retail sale (Brandon and Ferreiro, 1998).

Composition of packed juice

Packed juice include water (predominant component), carbohydrate (sucrose, fructose, glucose and sorbitol), small amount of protein, minerals, Vitamin A and C, cholesterol and unless the pulp is included, contains no fiber and no fat (Parish, 1991; Pao *et al*., 2000; Souza *et al.*, 2004). The anti-oxidants has been reported to decrease the risk of cancer and heart disease (Boyer and Liu, 2004; AICR 2010). The fruit juices prepared from tropical fruits like *Irvingia gabonensis* (African mango) have fairly high amount of antioxidants (Boakye *et al*., 2015). Ascorbic acid aids in iron absorption from food and is essential for children who consume diet with low iron bioavailability (Heldman and Lund, 1998; Ray, 2001; Oranusi *et al*., 2012). The concentaration of ascorbic acid depends upon the temperature at which packed juice is stored. Low temperatures help to maintain a higher level of Vitamin C, as well as many other juice components. Nitrate and nitrite concentration in packed juice also varies according to their origin, storage condition and processing technologies (Johnson and Kross, 1990). In recent years consumers have increasingly sought so-called "fresh" products stored in refrigeration. Keeping the juice at lower temperatures will prevent flavor deterioration by thermo-resistant bacteria but it will also prevent off-flavor caused by oxidation of the juice (Hossain *et al.*, 2016). Low temperatures will also help to maintain a higher level of Vitamin C, as well as many other juice components, with consequent better flavor of this product. This has led to research leading to development of alternative processing technologies to produce foods with a minimal changes induced by the technologies themselves.

Microbiology of packed juices

Microbiological analysis of industrialized food products, such as fruit juices, showed the presence of specific and potentially deteriogenic contaminants viz. heterotrophic bacteria, molds and yeasts. The unique properties of acidic juices are responsible for the elimination of the majority of the pathogenic microorganisms which can

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contaminate juice. However, fruit juices are suitable substrates/environments for specialized deteriogenic microorganisms, particularly bacteria and yeast, capable of surviving the high temperature treatments and able to grow at low pH. These microorganisms may promote the deterioration of juices by degrading some of their compounds (such as carbohydrates, protein and vitamins), producing undesirable odour and off-flavour, coloration, pH and texture changes. The storage of concentrated juice (around 66°Brix) under freezing conditions inhibits the deteriogenic action. Nevertheless, after reconstitution with water (around 11°Brix), the product becomes susceptible to contamination and deteriogenic action of microorganisms. When the reconstituted juice is pasteurized in the last stages prior to bottling, the vast majority of the vegetative forms of microorganisms are eliminated. However, dormant forms (spores) of some bacteria are resistant to the pasteurization process and in juice find a favorable environment for germination and growth. Bacteria species reported with processesed fruit juices (acidic food pH <4.5) include microorganisms e.g. *Bacillus, Clostridium, Lactobacillus, Leuconostoc* and acetogenic bacteria (Murdock and Hatcher, 1975). *Streptococcus* and *Pediococcus* species are found rarely in processed fruit juice. *Alicyclobacillus* spp. have been considered only recently as target-organisms for product quality evaluation, being associated with contamination of acidic fruit juices and preserves, soft drinks and isotonic drinks. Lactic acid bacteria comprise the most important group in deterioration processes of industrialized fruit juices (Parish, 1991). Several species included in genera *Lactobacillus* and *Leuconostoc* have been reported as responsible for producing off-flavour and off-odour, similar to the "acid butter or milk". Currently, it has been established that the diacetyl produced by lactic acid bacteria is partially responsible for that undesirable flavour and odour in the orange juice (Nagy 1996). Sporulating forms have a distinct role in food deterioration. This is due to the high thermal resistance of the spores, which in some species are still viable after the high temperature treatments associated with the pasteurization process. However, due to the low pH of orange juice, the few species that can grow in such substrate are mainly from the genus *Bacillus*. Besides *Alicyclobacillus,* other spore-forming bacteria such as *Bacillus* and *Clostridium* species have also been found in fruit juices. The flat-sour spoilage (due to production of lactic acid without gas formation) of tomato juice, soft drink and canned fruits is due to *Bacillus* spp., *B. macerans, B. polymyxa, B. licheniformis* and *B. subtilis* (Lucas *et al*., 2006; Vasavada, 2003). The spoilage in mango and orange juices as well as in tomato paste is also caused by *B. megaterium* and *B. coagulans* (Silva and Gibbs, 2004). Besides juices can be contaminated by anaerobic spore-forming bacteria such as *Clostridium butyricum* and *Clostridium pasteurianum* (producing gas and butyric odors) and some lactic acid bacteria such as *Lactobacillus brevis* and *Leuconostoc mesenteroides* (causing vinegary, buttermilk off-odors) and some heat-resistant mycelial fungi such as *Byssochlamys nivea* and *Talaromyces flavus* (Silva and Gibbs 2004; Steyn *et al.*, 2011). Acetic bacteria, also produce diacetyl, the main indicator of deterioration in orange juice. This group, due to its strictly aerobic characteristics and fastidious growth, is not considered an indicator of product quality. Its occurrence as juice contaminant is rare, compared to lactic acid bacteria (Nagy 1996). Anaerobic microorganisms, such as *Propionibacterium cyclohexanicum*, (Kusano *et al*., 1997), may also spoil fruit juice. This microorganism does not sporulate and is known by the ability of its vegetative form to survive the pasteurization temperatures and to grow at acidic to neutral pH (3.2 to 7.5) at the mesophilic temperature range. Propionibacterium cyclohexanicum can survive pasteurization regimes of 90˚C for 10 minutes.

Illness caused due to contamination and adulteration

Contamination and adulteration in edibles can lead to a number of diseases such as paralysis, cancer, mental retardation and hypertension etc. Several diseases associated with the consumption of fruit juices have been reported at several places around the globe (Mosupye and Holy, 2000; Muinde and Kuria, 2005; Chumber *et al*., 2007). Sources of contamination could be unhygienic water, contaminted ice, preservation without refrigeration, unhygienic surroundings and airborne dust. Food adulteration is one of the factors responsible for the illness. Contaminated juices may harbor *Escherichia coli, Salmonella* spp., *Shigella* spp. and *Staphylococcus aureus* (Buchmann *et al*., 1999; Sandeep *et al*., 2004; Barro *et al*., 2006).There have been documented outbreaks of illness due to pathogens which include *Salmonella* and Vero toxin producing *Escherichia coli* 1-2. In 1995, unpasteurized fresh orange juice contaminated with *Salmonella* was linked to an outbreak in a Florida Theme Park, USA. More than 60 visitors were affected (Mahale *et al*., 2008). In Australia, 427 confirmed cases of salmonellosis were reported in 1999 after the consumption of unpasteurized orange juice (Victorian Government Department of Human Services 2005). A total of 48

cases of *Escherichia coli* O157 were reported after drinking unpasteurized apple juice in Washington DC in 1996 (Victorian Government Department of Human Services 2005).

Researches based on this study

Many researches had been conducted to check the quality of fruit juices whether it processed or unprocessed. The aim of these researches was to identify various microorganisms like Bacteria, fungi; which generally contaminate food products. One of the researches was conducted in Bangladesh where twenty six vendor fruit juices and 15 packed juices were examined for the presence of total bacterial load, coliforms and *Staphylococci* (Rashed *et al*., 2013). Another study conducted to evaluate the quality of six different brands of mango juices packed in Tetra Pak for nutritional quality evaluation. Three samples were found to contain total soluble solids less than the standard limit prescribed by Pakistan Food Laws (Akhter, 2012). One other study was done in which fifteen samples of packaged fruit juices which include pineapple, orange, and apple juice were analyzed for their microbial content using standard microbiological techniques. The fruit juices were purchased from street hawkers in Port Harcourt Metropolis, Nigeria. The study showed the presence of *Bacillus* sp, *Micrococcus* sp, *Flavobacterium* sp., *Lactobacillus* sp, *Penicillum* sp. and *Saccharomyces* species. The study has also shown that these packaged fruit juices are not sterile and thus can favour the growth of microorganisms when conditions become favourable, which could pose a public health risk to their consumers (Nma and Ola, 2013).

Conclusion

Globalization makes the production and use of fruit juices abroad easier. Predictive microbiology and risk assessment may play an important role as alternatives to improve the microbiology of fruit juices, by providing optimized and scientifically sound measures regarding the behavior of either pathogens or spoilage microorganisms. Owing to the particular concern of microbial food safety not only because of the high prevalence of food-borne illness and other hazards associated with food, but also because of the considerable economic and social costs, an effective and environmentally friendly antimicrobial agent in food industry is highly required. Quality needs to be maintained for betterment of the consumers. This can be done by improving preprocessing and post processing techniques. Government should set a strict quality control unit so that there can 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. One of the important measures in this regard is to create awareness among the public regarding how to check the quality of packed fruit juices before consumption.

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