Pakistan Journal of Nutrition 1 (2): 79-81, 2002

Nutritional Value and Microbiological Safety of Fresh Fruit Juices sold through Retail Outlets in Qatar

J. H. Al-Jedah and R.K.Robinson*
Food Control Laboratory, Doha, Qatar
* School of Food Biosciences, University of Reading, Reading, England

Abstract: The nutritional value of ten fresh fruit juices purchased from retail outlets in Doha, Qatar was calculated on the basis that approximately 100 g of fruit is used to make one glass of juice (250 ml). Avocado juice was the best source of energy and potassium followed by banana juice, while guava juice was an outstanding source of vitamin C and carotene. By contrast, the microbiological quality of all the products was well outside the Gulf Standards for fruit juices, and coliform counts usually exceeded 1,000 cfu ml^{-1}. In one sample of mixed fruit juice, the coliform count was above 1.0×10^6 cfu ml^{-1}, and both *Escherichia coli* and *Enterococcus faecalis* (1.0×10^7 cfu ml^{-1}) were detected. It is concluded that, while the practice of consuming fresh fruit juices with meals should be encouraged on nutritional grounds, steps must be taken to improve the microbial quality of the products.

Key words: Fruit juices, nutritional value, microbiological quality

Introduction

In Qatar, as well as in most countries in the Middle East, the hot climate means that the intake of liquids must be high to compensate for the inevitable losses from perspiration and respiration. Even in air-conditioned buildings, the need for cool drinks is unavoidable. At one time, cool drinks purchased alone or with meals tended to be in factory-filled cans or bottles but, recently, two additional sources of 'water' have become important. Locally-bottled or imported spring water has become widely popular but, for more social occasions, fresh fruit juices are often the beverages of first choice. Most restaurants, cafes and, even, road-side stalls have on-site facilities for extracting the juice from fresh fruits like oranges, mangoes and any other fruits that may be available, and then serving the juice, liberally dosed with ice, to their thirsty customers.

Such drinks have much to recommend them. They are extremely pleasant on the palate and they contain most of the minerals and vitamins found in the original fruit but, bearing in mind their method of extraction, an inevitable question arises over safety. For example, the outside of the fruit may not be washed before it is placed in the juice extractor and, even if it is washed, the total colony count may well exceed 1.0×10^5 colony-forming units (cfu) cm^{-2} (Splittstoesser, 1979; Harrigan, 1998). Clearly many of these micro-organisms will be harmless yeasts and saprophytic bacteria, but this confidence does not mean that pathogens like *Listeria monocytogenes* or *Escherichia coli* may not be present as well (Bryan, 1977). How many of these micro-organisms will enter the juice itself will vary with the system of extraction, but it is more than likely that some degree of contamination always occurs.

Then the glasses and the fruits have to be handled by the operator of the extraction system so that, if high standards of hygiene are not observed, faecal coliforms could contaminate the drink along, perhaps, with *Staphylococcus aureus*. The use of tap water from a poorly-maintained storage tank or water from a bore-hole to fill the glass to the required volume may pose an additional risk. Thus, both *Aeromonas hydrophila* (Fernandez *et al.*, 2000) and *Cryptosporidium parvum* (Levine *et al.*, 1991; Mazounie *et al.*, 2000) have been detected in Municipal Water Supplies, while *L. monocytogenes* and *Yersinia enterocolitica* have been isolated from drinking water from wells (Korhonen *et al.*, 1996). Equally relevant could be the finding of Wang and Doyle (1998) that *E. coli* 0157 could survive in a viable state in water for 12 weeks at 25°C and, although in a non-culturable condition, there was no evidence to suggest that the same cells could not have been infective.

A further aspect of concern is the quality of the fruits themselves for, as the juice is the only component examined closely by the consumer, it would be comparatively easy to make use of sub-standard fruit. Infections with moulds like *Penicillium expansum* could easily pass unnoticed, and yet entry of the mycotoxin, patulin, into the juice would represent a long-term risk that should not be ignored (Sharma and Salunkhe, 1991).

Table 1: Potential nutritional value of samples of fresh fruit juices purchased from retail outlets in Qatar; all figures [g (kJ - energy) in a 250 ml portion] based on the inclusion of 100 g of whole fruit pulp/juice made up to 250 ml of juice as consumed

Type of Juice	Protein	Fat	Carbohydrate	Energy	Fibre*
Apple	0.4	0.1	11.8	199	1.8
Avocado	1.9	19.5	1.9	784	3.4
Banana	1.2	0.3	23.2	403	1.1
Carrot	0.6	0.3	7.9	146	2.4
Guava	0.8	0.5	5.0	112	3.7
Lemon	1.0	0.3	3.2	79	NA
Mango	0.7	0.2	14.1	245	2.6
Orange	1.1	0.1	8.5	158	1.7
Pineapple	0.4	0.2	10.1	176	1.2
Strawberry	0.8	0.1	6.0	113	1.1

*Determined by Englyst Method N.A = Not Available
(After: Holland *et al.,* 1991).

Consequently, the aim of this survey was to: (a) collect samples of freshly extracted juices from restaurants and cafes around Doha, the capital of Qatar; (b) calculate, on the basis of literature values and the approximate weight of fruit used per glass of juice, the likely nutrient content of certain selected juices; and (c) examine the juices for total colony count, coliforms, *E. coli* and yeasts and moulds as indicators of general standards of hygiene, *Pseudomonas aeruginosa* which can be present if the tap water has not been correctly handled at the treatment plant and *Staph. aureus* and *Enterococcus faecalis* as possible indicators of poor personal hygiene among the operatives; *Ent. faecalis* is regarded by some authorities as a better indicator of faecal contamination than faecal coliforms (Harrigan, 1998).

Materials and Methods

Six local restaurants were selected on the basis of size and general appearance with respect to cleanliness, and each restaurant was visited in turn. At each restaurant, two glasses of juice covering the entire range usually available, namely apple, avocado, banana, carrot, guava, lemon, mango, mixed fruit, orange, pineapple and strawberry, were ordered without ice and, on receipt, the juice was decanted into a sterile Duran bottle (500 ml). At the same time, around ten ice cubes were transferred with sterile tongs from the ice-bucket to a wide-mouth sterile screw-cap jar. Both the bottle of juice and the jar of ice were then transported immediately to the Central Food Laboratory in Doha in a cool box held at

Table 2: Potential nutritional value of samples of fresh fruit juices purchased from retail outlets in Qatar; all figures (mg in a 250 ml portion) based on the inclusion of 100 g of whole fruit pulp/juice made up to 250 ml of juice as consumed

Type of Juice	Vitamins			Minerals		
	C	B-group	Carotene	Potassium	Calcium	Iron
Apple	6	0.31	0.018	120	4	0.1
Avocado	6	1.74	0.016	450	11	0.4
Banana	11	1.09	0.021	400	6	0.3
Carrot	6	0.55	8.100	170	25	0.3
Guava	230	0.32	435.000	230	13	0.4
Lemon	58	0.5	0.018	150	85	0.5
Mango	37	0.72	1.800	180	12	0.7
Orange	54	0.65	0.028	150	47	0.1
Pineapple	12	0.5	0.018	160	18	0.2
Strawberry	77	0.72	0.008	160	16	0.4

(After: Holland *et al.,* 1991)

Table 3: Microbiological quality of samples of fresh fruit juices purchased from retail outlets in Qatar; all counts as colony-forming units ml^{-1} of juice - the range of counts found is shown by the figures for 'lowest' and 'highest' in brackets

Type of Juice	Total Colony Count	Coliforms	Yeasts and Moulds
Apple	6.6×10^4	1.4×10^3	1.0×10^4
	(2.0×10^4 - 1.5×10^5)	(20 - 4.0×10^3)	(100 - 2.5×10^4)
Avocado	4.9×10^6	9.3×10^3	4.0×10^4
	(1.8×10^6 - 1.0×10^7)	(8.0×10^3 - 1.0×10^4)	(200 - 2.0×10^5)
Banana	2.2×10^6	3.2×10^3	3.4×10^4
	(1.0×10^3 - 1.5×10^7)	(ND - 3.5×10^4)	(ND - 6.0×10^5)
Carrot	1.2×10^7	9.7×10^4	3.6×10^4
	(1.0×10^5 - 1.5×10^7)	(ND - 2.9×10^5)	(ND - 3.0×10^5)
Guava	1.3×10^5	1.0×10^3	< 10
	(6.0×10^4 - 2.0×10^5)	(110 - 2.0×10^3)	(ND - 200)
Lemon	3.0×10^8	ND	1.0×10^4
	(7.5×10^5 - 6.0×10^8)	(ND)	(ND - 2.0×10^4)
Mango	1.3×10^5	820	3.2×10^4
	(7.0×10^3 - 1.9×10^5)	(ND - 4.0×10^3)	(ND - 5.0×10^5)
Mixed Fruit	5.7×10^6	1.6×10^5	1.0×10^7
	(1.5×10^5 - 1.4×10^7)	(120 - 1.2×10^6)	(600 - 1.0×10^8)
Pineapple	1.5×10^5	1.9×10^3	3.2×10^4
	(9.0×10^3 - 3.0×10^5)	(400 - 4.0×10^3)	(200 - 1.3×10^5)
Strawberry	3.0×10^5	2.7×10^3	3.0×10^4
	(6.0×10^4 - 5.5×10^5)	(ND - 1.6×10^4)	(ND - 3.2×10^5)
Ice*	2.4×10^3	200	ND

* = typical result ND = None Detected

Table 4: The recommended Microbiological Standards for any fruit juice sold in the Gulf Region; all figures per ml of juice as consumed

	Total Colony Count	Coliforms	Yeasts and Moulds
Maximum Count Anticipated	5.0×10^3	10	100
Maximum Count Permitted	1.0×10^4	100	1.0×10^3

Where:

* The number of samples (n) to be examined equals 5.
* None of the 5 samples should have counts in excess of Maximum Permitted Limit; any sample with a count above Maximum Count Permitted shall be designated as "defective".
* No more than 2 out of the 5 samples should have counts in excess of Maximum Count Anticipated; any sample with a count above Maximum Count Anticipated shall be designated as "marginally acceptable".

After: Gulf Standards (2000)

approximately 4°C with sealed polythene bottles of frozen water. At the Laboratory, the bottles of juices and the jar of ice were stored in a refrigerator (4 - 5°C) for around two hours for the ice to melt, at which time both the juices and the ice were examined for total colony count, coliforms and *E. coli*, *Staph. aureus*, *P. aeruginosa*, *Ent. faecalis* and yeasts and moulds. In every case, the counts were determined using the procedures specified in AOAC (1995).

This same approach was adopted on each visit.

Results and Discussion

An estimate of the gross chemical composition of the juices is shown in Table 1, and there appear to be some marked differences between the juices. The high fat content of the avocado juice is not unexpected and, although this is reflected in the high energy value, the energy to be gained from consuming banana juice will be more available; around 85% of the carbohydrate in the banana is in the form of readily metabolisable sugars.

Citrus juices are a good option for gaining vitamin C, for a glass of either orange or lemon juice (Table 2) would provide a level in excess of the current Recommended Daily Allowance (UK-RDA) of 40 mg (Anon., 1994). Strawberry juice, while not being so readily available in restaurants as the citrus juices, can be especially rich in vitamim C as is guava juice, and even consumption of the more popular mango will provide close to the UK-RDA. Vitamins of the B-group are present in most juices as is carotene but, as shown in Table 2, the carrot and guava juices would seem to be the only major sources of carotene.

As far as minerals are concerned, the citrus juices are a useful source of dietary calcium, but the potassium - sodium balance in

the body may well be enhanced by consuming avocado or banana juice. This point could be extremely relevant for the Middle East where the intake of sodium from salty foods like Feta cheese can be quite high.

Obviously it is not suggested that all fruit juices can make a major input to a diet, but they could certainly be recommended ahead of drinks like Coca-cola or Pepsi-cola. However, while the latter drinks are unlikely to pose any microbiological risk for the consumer, fresh fruit juices are, by their very nature, exposed to the risk of contamination during preparation and are not subject to any preservative treatment prior to being drunk. It was for this reason that the same selection was examined for general microbial quality - total colony, coliform and yeast and mould count, as well as for specific pathogens.

The results are shown in Table 3, and means are given for each juice along with range of counts found. The recommended specifications for fruit juices sold in the Gulf Region are shown in Table 4, and it is clear that the total colony counts and coliform counts - with the exception of lemon juice - exceed the expected standards by a considerable margin. However, while these high counts are well in excess of any reasonable specification, e.g. over one million coliforms per ml of Mixed Fruit juice, it is important that they may not necessarily pose a hazard to the health of the consumer.

Thus, a number of genera from within the coliform group are widely found on vegetable tissues and pose no hazard to humans, but it is the possible presence of *E. coli* and *Salmonella* spp. under the same 'umbrella' that is a cause for concern. Melon, for example, is likely to have a pH above 6.0 so that, if a sliced fruit was to be contaminated with *Salmonella*, rapid growth could occur prior to the fruit being blended into a juice (Golden *et al.*, 1993). This concern was highlighted with one sample of Mixed Fruit juice which gave a coliform count of 1.6×10^5 cfu ml^{-1} that included *E. coli*, and a count for *Ent. faecalis* of 1.0×10^7 cfu ml^{-1}. The concomitant presence of *Staph. aureus* (87 cfu ml^{-1}) suggests that this sample of fruit/juice had been severely contaminated by human contact, and clearly this level and type of contamination is totally unacceptable.

As fruits usually carry a rich microflora of yeasts and moulds, it is not suprising, perhaps, that the counts in the juices were often very high ($> 1.0 \times 10^5$ cfu ml^{-1}), and usually well above the Gulf Standard. However, it is relevant that juices of this type are consumed immediately after preparation and that few yeasts are pathogenic to humans, so that the actual health risk from this group should be minimal. Nevertheless, the presence of yeasts and moulds in many of the juices suggests that the practices involved with the handling of the fruits and the extraction of the juices leaves a lot to be desired with respect to hygiene.

The high level of coliforms detected in the ice should not have been present, but the absence of *Ps. aeruginosa* confirms that the water employed to make the ice had been properly treated at source.

Conclusion

The selected nutrient values shown in Tables 1 and 2 suggest that the current trend to buy fruit juices to accompany a meal or snack has much to recommend it. Inevitably, each juice provides a different range of those components that are desirable in a diet. Banana juice can provide a welcome source of readily-available energy as well as boost the intake of potassium, while a glass of guava juice meets the UK-RDA for vitamin C many times over, as well as supplying a level of carotene found in few other sources. However, these natural benefits will be lost if the microbial quality of the products is so low that consumers are placed at risk of contracting a food-borne infection. How the Authorities can combat this threat is another matter, for while the Standards published by the GCC cannot be faulted, ensuring compliance may prove more difficult.

References

Anon., 1994. Dietary Reference Values for Food Energy and Nutrients for the United Kingdom. HMSO, London.

AOAC., 1995 Bacteriological Analytical Manual, 13th edn. Association of Official Analytical Chemists, Gaithersburg, USA.

Bryan, F.L., 1977. Diseases transmitted by foods contaminated by wastewater. J. Food Protection, 40: 45-56.

Fernandez, M.C., B.N. Giampaolo, S.B. Ibanez, M.V. Guagliardo, M.M. Esnaola, L. Conea, P. Valdivia, S. M. Stagnaro and C. Chiale, 2000. *Aeromas hydrophila* and its relation with drinking water indicators of microbiological quality in Argetine. . Genetica, 108: 25-40.

Golden, D.A., E.J. Rhodehamel and D.A. Kautter, 1993. Growth of *Salmonella* spp. in canteloupe, watermelon and honeydew melon. J. Food Protection, 56: 194-196.

Gulf Standards, 2000. Microbiological Criteria for Foodstuffs - Part 1. GCC, Riyadh, Saudi Arabia.

Harrigan, W.F., 1998. Laboratory Methods in Food Microbiology. Academic Press, London.

Holland, B., I.D. Welch, I.D. Unwin, D.H. Buss, A.A. Paul and D.A.T. Southgate, 1991. McCance and Widdowson's The Composition of Foods, Royal Society of Chemistry, London.

Korhonen, L.K., M. Niskanen, H. HeinonenTanski, P.J. Martikainen, L. Salonen and I. Taipalinen, 1996. AMBIO, 25: 343-349.

Levine, W.C., W.T. Stephenson and G.F. Craun, 1991. Waterborne disease outbreaks, 1986-1988. J. Food Prot., 54: 71-78.

Mazounie, P., F. Bernazeau and P. Alla, 2000. Removal of *Cryptosporidium* by high rate coarse filtration. Water Sci. Technol., 41: 93-101.

Sharma, R.P. and D.K. Salunkhe, 1991. Mycotoxins and Phytoalexins (Eds.) CRC Press, Boca Raton, USA.

Splittstoesser, D.F., 1979. Fruits and Fruit Products. In: Food & Beverage Mycology.Ed. Beuchat,L.R. AVI Publishing Co. Inc, Westport, Connecticut.

Wang, G.D. and M.P. Doyle, 1998. Survival of enterohemorrhagic *Escherichia coli* 0157:H7 in water. J. Food Protection, 61: 662-667.