IJFANS
International Journal of Food And Nutritional Sciences

Volume 3, Issue 1, Jan-Mar-2014, www.ijfans.com e-ISSN: 2320-7876

Official Journal of IIFANS

INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

e-ISSN 2320 –7876 *www.ijfans.com*
Vol.3, Iss.1, Jan-Mar 2014

Research Paper *Open Access*

IDENTIFICATION OF MICROBIAL HAZARDS ASSOCIATED WITH THE FRESH PRODUCE SOLD IN SOUTH DELHI MARKETS AND THEIR MINIMIZATION

Shalini Sehgal*and Swati Mehta
Department of Food Technology, Bhaskaracharya College of Applied Sciences,
University of Delhi, Sector-2, Phase-I, Dwarka, New Delhi.

*Corresponding Author:shalinisehgal72@gmail.com

ABSTRACT

Fruits and vegetables can become contaminated with microorganisms capable of causing human diseases while still on the plant in fields or orchards, or during harvesting, transport, processing, distribution and marketing, or in the home. Interventions to minimize contamination of fruits and vegetables at any point in the chain should be preferred to remedial or corrective action (agriculture, transport, manufacturing and processing, distribution, and preparation for consumption). In the present study, 200 samples of fresh fruits and vegetables were collected from South Delhi, both local and retail markets. Then, the total microbial load, yeasts and molds on their surface were estimated. Presence of Coliform and *Escherichia coli* was also detected. Majority of samples were found to be contaminated and the highest microbial load was found in beetroots (4.85 log counts per gram) and lowest in pears (4.18 log count per gram). The bacterial counts were found to be higher than the Yeast and Molds counts. Then, to eliminate the surface microbial load, various types of antimicrobial dips in varying concentration were used. Among, all the three types of antimicrobial dips, the most effective were found to be citric acid at 1% concentration.

Key words: Pathogens, Total Plate Count (TPC), Yeast and Mold count (YMC), Total Coliforms, *Escherichia coli*, Antimicrobial dip, Fruits and Vegetables.

INTRODUCTION

Fruits and vegetables are unique foods since they are often consumed raw or with minimal preparation. To date, there have been no effective interventions strategies developed which can completely eliminate food safety risks associated with consumption of uncooked produce. Therefore, preventing contamination with human pathogens, dangerous levels of chemical residues, or physical contaminants is the only way to assure these foods are wholesome and safe for human consumption.

Raw and minimally-processed fruits and vegetables are an essential part of people's diet all around the world. Where land is available, families grow fruits and vegetables for their own use. Alternatively, produce is purchased from local farmers or retail outlets for further preparation by street vendors, by families at home or as part of meals eaten in restaurants and other food-service facilities. While advances in agronomic practices, processing, preservation, distribution and marketing have enabled the raw fruit and vegetable industry to supply high-quality produce to many consumers all year round, some of these same practices have also expanded the geographical distribution and incidence of human illness associated with an increasing number of pathogenic bacterial, viral and parasitic microorganisms.

With increased concerns over failures in vegetable and fruit sanitation, evaluating the efficacy of widely approved chemicals is ever more important. The purpose of this study was to determine whether sanitation treatments are equally effective against indicator bacteria and human enteric pathogens on selective fruits and vegetables.

The antimicrobial dips in varying concentration will be tested for their efficacy against the surface micro flora. This may help in creating a debate about the necessity of the use of antimicrobial dips and their contribution to food safety.

PATHOGENS CAUSING CONTAMINATION

A wide range of enteric pathogens and their toxins can be transmitted via food, including the bacteria *Campylobacter spp., Salmonella spp., Shigella spp., enterovirulent E. coli, Clostridium botulinum, Listeria monocytogenes, Clostridium perfringens*, some *Bacillus spp., Staphylococcus aureus*, the protozoa *Cryptospordium parvum, Cyclospora cyatenenesis and Giardia spp. and* viruses such as *Norwalk-like viruses* and *Hepatitis A.*

Given the widespread use of human and animal faecal waste in agricultural practice it is not surprising that enteric pathogens can contaminate agricultural produce and cause outbreaks of illness following consumption. Spores of *Clostridium botulinum*, *Clostridium perfringens*, and *Bacillus cereus* can also be isolated from soil free from faecal contamination and *Listeria monocytogenes* can be found in decaying vegetables (De Rover, 1998)

Fruits and vegetables can become contaminated with microorganisms capable of causing human diseases while still on the plant in fields or orchards, or during harvesting, transport, processing, distribution and marketing, or in the home. Bacteria such as *Clostridium botulinum*, *Bacillus cereus* and *Listeria monocytogenes*, all capable of causing illness, are normal inhabitants of many soils, whereas *Salmonella*, *Shigella*, *Escherichia coli* and Campylobacter reside in the intestinal tracts of animals, including humans, and are more likely to contaminate raw fruits and vegetables through contact with faeces, sewage, untreated irrigation water or surface water. Contamination may also occur during post-harvest handling, including at points of preparation by street vendors, in food-service establishments and in the home. Contamination with viruses or parasites can result from contact with faeces, sewage and irrigation water (Cliver, 1997).

Factors contribute to real increases in diseases associated with fruits and vegetables (Hedberg et al., 1994). These include use of wastewater, increased application of improperly composted manures to soils in which fruits and vegetables are grown, changes in packaging technology such as the use of modified or controlled atmosphere and vacuum packaging, extended time between harvesting and consumption, and changing food consumption patterns (e.g. eating more meals away from home, including greater use of salad bars). Increased global trade in raw fruits and vegetables, as well as increased international travel in general, could also increase the risk of produce-associated diseases.

Good hygienic practice during production and transport, including sanitizing of harvesting equipment and transport vehicles, as well as the application of good hygienic practice during processing and preparation are critical. Elimination of animals and insects from processing, storage, marketing and food-service facilities should be a goal of anyone who handles raw produce. The highest level of hygiene must be practiced by all handlers (including consumers) of fruits and vegetables, from the field to the table, if any degree of success is to be achieved in minimizing the risk of contamination.

The presence of a pathogen on produce is of less consequence if the rind, skin or peel is to be removed before consumption. Bananas, melons, mangoes, durians, pineapples and papayas, for example, fall in this category. However, the process of removing the rind, skin or peel from these fruits, perhaps with the exception of bananas, may result in contamination of the edible portion, thereby creating a risk to the consumer. Microorganisms that have become trapped on the inner leaves of certain vegetables can be particularly difficult to remove by routine cleansing practices.

Application of improperly composted manure or water containing raw sewage to fields, or the use of water contaminated with faeces during processing of fruits and vegetables must be avoided. These responsibilities must be shared by the grower as well as the processor, shipper, distributors and food handlers. Training of food handlers at all level of the food chain, as well as education of the consumer, is key elements in a total system approach to reducing the risk of produce-borne illnesses.

REMEDIAL MEASURES TO CONTROL THE SURFACE MICRO FLORA OF FRUITS AND VEGETABLES

To minimize the risk of infection or intoxication associated with raw fruits and vegetables, potential sources of contamination from the environment to the table should be identified and specific measures and interventions to prevent and/or minimize the risk of contamination should be considered and correctly implemented. Food handlers and consumers need to observe good hygienic practice during processing and preparation of these foods for consumption, including treatments for reducing the number of pathogens.

The first washing of vegetables at harvest removes much of the adhering soil and dirt. However, it should be recognized that washing may also be a source of microbial contamination.

Even where washing is applied, effective washing and decontamination of ready-to eat fruits and vegetables (including fresh leafy herbs) are difficult. Not all commodities lend themselves to being washed. Some e.g., strawberries and mushrooms depreciate in quality if they are washed prior to marketing. Studies show that the effect of washing in reducing the number of bacteria present is small with reductions of 0.1 to 1 log10 units (Beuchat et al., 1998).

Various disinfectants can be used to reduce the microbial load on fruits and vegetables. The purpose of using these agents is to control plant pathogens (plant protection) or food pathogens or spoilage organisms (preserving additive). The effect of disinfectants on contaminants depends on many factors including the concentration used, treatment time, temperature, pH and sensitivity of the target organism(s).

Chemical disinfection methods to date have used a wide range of chemicals. These mostly use Chlorine in one form or the other. Organic Acids, Chlorine Dioxide, Hydrogen Peroxide and Ozone are used or may be used (Beuchat, 1998).

As researchers approach the problem of improving the safety of fresh produce, some of the basic concepts have altered a little whilst others remain the same. Decontamination is the fundamental key to successful disinfection. If extraneous soil and detritus are not first removed from the product, disinfectant cannot totally access the product effectively. Also, the disinfectant may be absorbed or inactivated by residual soil which reduces its availability.

OBJECTIVES

This study is aimed at identifying and reducing the microbial risk associated with raw fruits and vegetables and their minimization. This study provides an overview of the hazards associated with fruits and vegetables eaten raw, review the methods used for their decontamination (particularly with reference to chemical methods) and evaluate the efficacy of these methods on the basis of available data as no such data is available for the Indian markets till date.

1. To enumerate the surface micro flora of selected fruits and vegetables using standard methods.
2. To compare and determine the total surface bacterial load of the selected fresh vegetables and fruits from local market/ retail outlets before and after the use of anti-microbial agents to reduce the microbial population in samples.

MATERIALS AND METHODS

LOCALE OF THE STUDY

Collection of samples from Local Markets (LM)/ Retail outlets or markets (RM) of South Delhi, India

SAMPLE COLLECTION AND PREPARATION

Two hundred samples of different fresh fruits and vegetables were analyzed during the course of this entire study, but currently, only five types of samples are being selected ,three samples from vegetables (cucumber, beetroot and french beans) and two from fruits (pear and apple). The number of samples in each case is 10 (n=10).These five samples were randomly collected aseptically in a sterilized container maintained in cold conditions, delivered to laboratory immediately and analyzed. All the samples were used for detection of Total Plate Count (TPC), Total Coliform, *E.coli* and Yeast and Mold (YMC). The elapsed time between the sample collection and the analysis did not exceed 3 hours.

SAMPLE PREPARATION

25 g of sub samples randomly taken were aseptically weighed and diluted with 225 ml of sterile peptone water (HiMedia, RM001), were vortexed (thoroughly mixed) for 2 min. Unprocessed and large sized fruits and vegetables were aseptically chopped into smaller pieces prior to weighing.

MICROBIOLOGICAL ANALYSIS

The homogenate from sample preparation in peptone water were used for the following procedures: Total Plate Count, Total Coliform counts, Yeast and Mold counts and *E.coli* detection.

TOTAL PLATE COUNT (TPC)

Total viable count of all the fruits and vegetables samples were determined by Plate count as described by APHA using Standard Plate Count Agar medium (Hi Media, M091). Serial dilutions were prepared aseptically. 1ml of the sample from different dilutions was inoculated into Plate Count Agar plates in duplicates. The samples were mixed by rotating, and then the pour plates were inverted and incubated at 37degree Celsius for 24 hrs. After incubation, colonies were counted and results were recorded as cfu/gram of the sample.

COLIFORM COUNT

Total Coliform count of all fruits and vegetables samples was determined by Direct Plate Count (APHA method) using Violet Red Bile Agar (Hi Media, M049). 1ml of the sample in peptone water was inoculated into Violet red bile agar by pour plating in duplicates. The samples were mixed by rotating, and then the pour plates were inverted and incubated at 37degree Celsius for 24-48 hrs. After incubation, colonies were counted and results were recorded as cfu/gram of the sample.

YEAST AND MOLD COUNT (YMC)

The Yeast and Mold count of all fruits and vegetables samples were determined by Direct Plate Count as in APHA using Potato Dextrose Agar, (Hi Media, M096). 0.1 ml of the samples serially diluted in sterile peptone water; was plated on Potato Dextrose Agar medium in duplicates by spread technique. The plates were incubated at 21degree Celsius for 5-7 days. After incubation, colonies were counted and results were recorded as cfu/gram of the sample.

***ESCHERICHIA COLI* IDENTIFICATION**

E. coli were determined by Tube Test method. Aliquots of stock solution (1 ml of the samples made in peptone water) were taken in 9 ml of Brilliant Green Lactose Bile Broth (Himedia M121S). Then broth is incubated at 44.5°C for 24 hrs; tubes were then observed for acid and gas production. Then for confirmation test, Streak 1 loopful from the positive tubes on plated Eosin methylene blue agar (Hi media M317). The plates were incubated at 37°C for 24hrs. After incubation, dark centered colonies with green metallic sheen are subjected to further biochemical test.

TREATMENT WITH ANTIMICROBIAL DIPS

TREATMENT SOLUTIONS

Samples were treated with three different Antimicrobial dips-200ppm Chlorine solution (using Suma tab from Diversey (4 tablets in 15 litre water), 1% citric acid solution (RM1023) and 1% Benzoic acid solution (RM1326). All solutions are prepared in sterile distilled water.

TREATMENT OF SAMPLES

Samples were immersed in respective antimicrobial solutions for 5min. 25g of treated subsamples were aseptically weighed and diluted in 225ml Peptone water and analyzed for their TPC, Total Coliform, Yeast and Mold and E.coli as per APHA standards. Observations of treated samples were compared with that of TPC of their initial counts.

STATISTICAL ANALYSIS

SPSS16 and Variance analysis methods (ANOVA) were used in interpretation of analysis results. T-Test was used in the evaluation of the significance of the difference between the groups. The significance between the values was evaluated at 95% confidence $p<0.05$.

RESULTS AND DISCUSSION

The consumption of fresh fruits and vegetables continues to increase owing to consumer preferences for fresher, more nutritious foods that also happen to meet the needs of busier lifestyles. Globalization of food supply introduces hazards from one region into other areas. The presence of numerous genera of spoilage bacteria, yeast and mold, and an occasional pathogen on fresh produce has been recognized for many years. Increased consumer demands in recent years for fresh “natural” and “organically” cultivated produce has increased the risk for food- handling errors and food borne illness associated with fresh produce. Contamination of fresh produce with microorganisms can occur during growth and processing, as well as in the home due to cross contamination. Several outbreaks of human gastroenteritis have been linked to the consumption of contaminated fresh fruits and vegetables. So, it has become necessary to check the microbial load on fresh fruits and vegetables to assess their safety for human consumption.

In the present study, the microbiological quality of 200 samples of fruits and vegetables were analyzed from South Delhi local market (LM) and retail market (RM). Out of 200 samples only five types of samples were considered for this study- three samples of vegetables (cucumber, beetroot and french beans) and two samples of fruits (pear and apple).

MICROBIOLOGICAL ANALYSIS

All the samples tested were found to be contaminated although the level of contamination varied. The level of contamination was found to be highest in beetroot and lowest in case of pears.

CUCUMBER

In this study, cucumber samples (n=10) were collected and analysed for Total Plate Count (TPC), Yeast and Molds (YMC), Total Coliform and E.coli. The TPC ranged from 3.9 to 4.56 log cfu/gram (refer Table 1). The samples were also analyzed for its Y&M counts which ranged from Nil to 1.08 log cfu/gram (refer Table 3). The coliform load range from 2.28 to 3.05 log cfu/gram (refer Table 2). Out of 10 samples, 8 samples are positive for *E.coli* (refer Table 4 and Figure 4)

Table 1. Showing Total Plate Counts (log count/g) for fruit and vegetable samples in local and retail market

Location code*	Cucumber	Beetroot	French beans	Apple	Pears
LM1	4.02	4.86	4.39	4.75	4.40
LM2	4.11	4.97	4.36	4.29	4.29
LM3	4.01	4.98	4.40	4.45	4.26
LM4	3.90	4.99	4.34	4.62	4.08
LM5	3.98	4.98	4.34	4.30	4.00
RM1	4.35	4.66	4.37	4.39	4.16
RM2	4.56	4.75	4.32	4.16	4.15
RM3	4.46	4.79	4.30	4.19	4.16
RM4	4.25	4.67	4.32	4.29	4.16
RM5	4.34	4.83	4.41	4.61	4.05

**(LM1, LM2, LM3, LM4, LM5, RM1, RM2, RM3, RM4, RM5) indicates sample numbers from Local and retail market respectively)*

BEETROOT

In this study, beetroot samples (n=10) were collected and analysed. The TPC ranged from 4.6 to 4.9 log cfu/gram (refer Table 1). The samples were also analyzed for its Y&M counts which ranged from 1.3 to 2.3 log cfu/gram (refer Table 3). The coliform load range from 2.81 to 3.47 log cfu/gram (refer Table 2). All samples are positive for *E.coli* (refer Table 4 and Figure 4).

Table 2. Showing Total Coliform Counts (log count/g) for fruit and vegetable samples in local and retail market

Location code*	Cucumber	Beetroot	French beans	Apple	Pears
LM1	2.40	3.26	2.32	1.60	1.00
LM2	2.34	3.34	2.26	1.95	1.78
LM3	2.56	3.08	2.46	1.30	1.48
LM4	2.28	3.47	2.38	1.00	1.00
LM5	2.38	3.23	2.34	1.60	1.48
RM1	2.81	2.94	2.26	2.38	1.60
RM2	3.05	2.81	2.08	1.30	1.60
RM3	2.80	3.05	2.26	1.30	1.48
RM4	2.69	2.90	2.26	1.60	1.00
RM5	2.61	2.83	2.08	1.30	1.30

**(LM1, LM2, LM3, LM4, LM5, RM1, RM2, RM3, RM4, RM5) indicates sample numbers from Local and retail market respectively)*

FRENCH BEANS

In this study, French beans samples (n=10) were collected and analyzed. The TPC ranged from 4.30 to 4.41 log cfu/gram (refer Table 1). The samples were also analyzed for its Y&M counts which ranged from Nil to

1.60 log cfu/gram (refer Table 3). The coliform load range from 2.08 to 2.46 log cfu/gram (refer Table 2). All samples are positive for *E.coli* (refer Table 4 and Figure 5)

Table 3. Showing Yeast and Mold Counts (log count/g) for fruit and vegetable samples in local and retail market

Location code*	Cucumber	Beetroot	French beans	Apple	Pears
LM1	1.30	2.32	1.48	Nil	Nil
LM2	Nil	2.38	1.60	1.48	1.48
LM3	1	2.20	1.48	Nil	Nil
LM4	Nil	1.78	Nil	1.48	Nil
LM5	1	2.32	Nil	Nil	Nil
RM1	Nil	1.70	1.30	Nil	Nil
RM2	Nil	1.30	1.60	Nil	Nil
RM3	1	1.95	Nil	Nil	Nil
RM4	1.08	1.85	Nil	Nil	Nil
RM5	Nil	1.90	Nil	Nil	Nil

**(LM1, LM2, LM3, LM4, LM5, RM1, RM2, RM3, RM4, RM5) indicates sample numbers from Local and retail market respectively)*

APPLE

In this study, apple samples (n=10) were collected and analyzed. The TPC ranged from 4.16 to 4.75 log cfu/gram (refer Table 1). The samples were also analyzed for its Y&M counts which ranged from Nil to 1.48 log cfu/gram (refer Table 3). The coliform load range from 1.30 to 2.38 log cfu/gram (refer Table 2). Out of 10 samples, 7 samples are positive for *E.coli* (refer Table 4 and Figure 4).

Table 4. Showing Prevalence of Escherichia coli in fruits and vegetable samples

S No.	Sample	*Escherichia coli*
1	Cucumber	8
2	Beetroot	10
3	French beans	10
4	Apple	7
5	Pears	8
Total No. of positive samples		43

Values are No. of positive samples out of total No. of samples collected i.e 10

PEAR

In this study, pear samples (n=10) were collected and analyzed. The TPC ranged from 4.00 to 4.4 log cfu/gram (refer Table 1). The samples were also analyzed for its Y&M counts which ranged from Nil to 1.48 log cfu/gram (refer Table 3). The coliform load range from 1.00 to 1.78 log cfu/gram (refer Table 2). Out of 10 samples, 8 samples are positive for *E.coli* (refer Table 4 and Figure 4)

EFFECT OF ANTIMICROBIAL DIPS

All the anti-microbial agents showed maximum reduction. In this study, the efficacy of three antimicrobial dips – Chlorine, citric acid and benzoic acid at 1% concentration for five minutes; was determined and their suitability and cost effectiveness was analyzed to reduce the microbial load in the fresh produce. Ten samples were taken and assessed for the antimicrobial effect of different sanitizing treatments. All the three antimicrobial dips were found to be equally effective. Citric acid and benzoic acid also reduced the microbial load to considerable levels (refer Table 5, 6 and 7). The initial TPC load on cucumber sample was found to be 4.2 log cfu/g and it was reduced to 3.73 with chlorine, 3.82 with Citric acid and 3.83 with benzoic acid (refer Table 5 and Figure 1). For beetroot, initial TPC load was 4.85 log cfu/g. It was reduced to 4.19 log /g with Chlorine, 4.23 with citric acid and 4.22 using benzoic acid (refer Table 5 and Figure 1). Initially, the TPC load on French beans was found to be 4.35 log cfu/g, Use of chlorine, citric acid and benzoic acid resulted in microbial load reductions to 3.02, 3.14 and 3.19 log cfu/g respectively (refer Table 5 and Figure 1). In case of pears, initially the TPC load was 4.18 log cfu/g which was effectively reduced by using Chlorine to 2.99 log cfu/g, citric acid to 3.16 log cfu/g and benzoic acid to 3.2 log cfu/g (refer Table 5 and Figure 2). Initially, the TPC load on apple was found to be 4.38 log cfu/g. Use of chlorine, citric acid and benzoic acid resulted in microbial load reductions to 3.97, 4.01 and 4.01 log cfu/g respectively (refer Table 5 and Figure 2).

Table 5. Showing the antimicrobial effect on the average (mean) TPC loads of fruits and vegetables

S No.	Sample	Average TPC microbial load (log cfu/gram)			
		Initial Count	Chlorine	Citric Acid	Benzoic Acid
1.	Cucumber	4.2	3.73	3.82	3.83
2.	French beans	4.35	3.02	3.14	3.19
3.	Beetroot	4.85	4.19	4.23	4.22
4.	Apple	4.38	3.97	4.01	4.01
5.	Pear	4.18	2.99	3.16	3.2

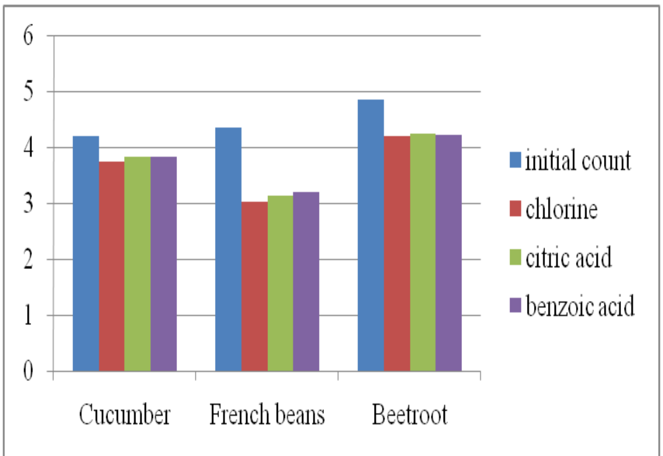

Figure 1- Effect of different antimicrobial dips on the average TPC load (mean) of vegetable samples (cucumber, french beans and beetroot)

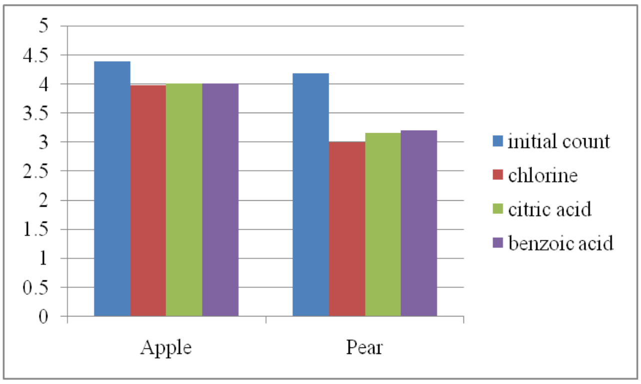

Figure 2. Effect of different antimicrobial dips on the average TPC load (mean) of fruit samples (apple and pear)

The initial Coliform load on cucumber sample was found to be 2.59 log cfu/g which was effectively reduced to 1.91 log cfu/g by using chlorine and to 1.87 log cfu/g by using both citric acid and benzoic acid (refer Figure 3 and Table 6). Initially, the Coliform load on French beans was found to be 2.29 log cfu/g (refer Figure 3 and Table 6), Use of chlorine, citric acid and benzoic acid resulted in microbial load reductions to 1.49, 1.24 and 1.39 log /g respectively (refer Figure 3 and Table 6). In case of beetroot, initially the Coliform load was 3.12 log cfu/g which was effectively reduced by using Chlorine to 2.08 log cfu/g, citric acid to 2.14 log cfu/g and benzoic acid to 2.17 log cfu/g (refer Figure 3 and Table 6). In case of Apple and Pears initial Coliform load were found to be 1.56 and 1.38 log cfu/g and it was reduced to Nil by using all three antimicrobial dips (refer Table 6).

Table 6. Showing the antimicrobial effect on the average (mean) Coliform loads of fruits and vegetables

S No.	Sample	Average Coliform microbial load (log cfu/gram)			
		Initial count	Chlorine	Citric acid	Benzoic acid
1	Cucumber	2.59	1.91	1.87	1.87
2	French beans	2.29	1.49	1.24	1.39
3	Beetroot	3.12	2.08	2.14	2.17
4	Apple	1.56	Nil	Nil	Nil
5	Pear	1.38	Nil	Nil	Nil

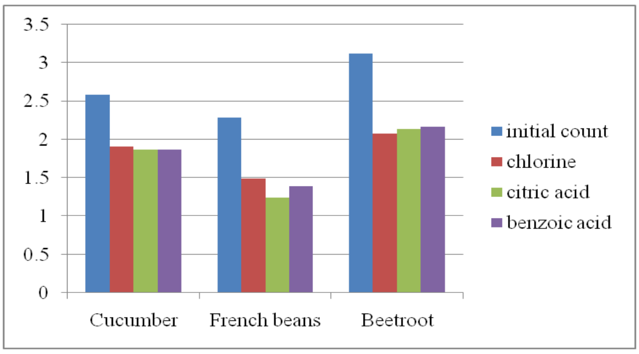

Figure 3. Effect of different antimicrobial dips on the average Coliform load (mean) of vegetable samples (cucumber, French beans and beetroot)

The initial load of Yeast and Mold was found 1.08, 1.52, 1.98, 1.48 and 1.48 log cfu/g in case of cucumber, French beans, beetroot, apple and pear respectively. Use of chlorine, citric acid and benzoic acid resulted in microbial load reductions to Nil (refer Table 7).

Table 7. Showing the antimicrobial effect on the average (mean) Yeast and Mold loads of fruits and vegetables

S. No	Sample	Average Yeast and Mold load (log cfu/gram)			
		Initial count	Chlorine	Citric acid	Benzoic acid
1.	Cucumber	1.08	Nil	Nil	Nil
2.	French beans	1.52	Nil	Nil	Nil
3.	Beetroot	1.98	Nil	Nil	Nil
4.	Apple	1.48	Nil	Nil	Nil
5.	Pear	1.48	Nil	Nil	Nil

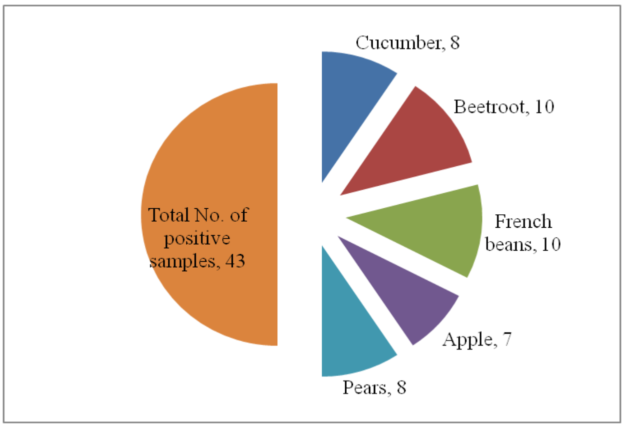

Figure 4. Prevalence of *E.coli* in Fruits and Vegetables

All the samples were initially positive for *E.coli* (refer Figure 4) and reduction was seen in *E.coli* load after using all three antimicrobial dips as found negative in all the samples.

CONCLUSION

In the present study, the microbial status of various fruits and vegetables samples was assessed. All the samples studied were found to be contaminated. The highest microbial load was found in case of beetroot followed by apple, French beans, cucumber and then pears, which can be attributed to the various internal and external sources of contamination .The usual trend is that the fruits and vegetables growing closer or within the soil are more contaminated. Similar trend was observed in this study too. Coliforms were present on majority of samples; exception was that of pears and apples. In case of apples, it can be due to the wax coating on their surface, which makes it impermeable to water. Yeasts and molds are the natural microflora of the fruits and vegetables and hence they were detected in majority of the samples. Presence of *E.coli* indicates poor water quality, untreated manure for the production of these crops.

Our study involved both unorganized and organized sector – local market and retail market. The level of contamination was highest in the local market where the fresh produce comes directly from the farmers / cooperatives or farmer societies. The trend also indicated that the local produce within Delhi was contaminated, only the retail samples were found to be of good quality as the fresh produce is usually dipped in the chlorine solution (200ppm) prior to packaging and distribution as found out by the survey of various retail outlets .

Since the majority of the samples were found to be contaminated, there was a requirement of finding an easily available and cost effective antimicrobial dip. Three solutions -200 ppm of chlorine solution, 1% Citric Acid solution and 1% benzoic Acid solution were studied for their antimicrobial property. All the three antimicrobial dips were found to be effective, but citric acid was the most effective as per statistical analysis (Paired test). Thus, it can be introduced as a cost effective antimicrobial dip for a developing country like ours.

REFERENCES

- Beuchat, L.R., Nail, B.V., Adler, B.B., Clavero, M.R., Efficacy of spray application of chlorinated water in killing pathogenic bacteria on raw apples, tomatoes and lettuce. J. Food Prot., 1998, 61, 1305-1311.
- Cliver DO (1997). Foodborne viruses. In: Doyle MP, Beuchat LR, Montville TJ (eds.) Food Microbiology: Fundamentals and Frontiers, p. 437-446. Washington, DC, American Society for Microbiology.
- De Rover C. 1998. Microbial safety evaluations and recommendations on fresh produce. Food Control 9(6): 321-347.
- Downes ,F.P. and Itō, K. ,Compendium of methods for the microbiological examination of foods, American Public Health Association,2001
- Hedberg CW, MacDonald KL, Osterholm MT (1994). Changing epidemiology of food-borne disease: a Minnesota perspective. Clin. Infect. Dis., 18:671-682.