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Research Article

EVALUATION OF PHYSICOCHEMICAL AND MICROBIAL QUALITY OF MINIMALLY PROCESSED SPROUTS

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ABSTRACT
Minimal processing (MP) is a promising technology to develop processed foods with fresh like quality for today's technological world. But the maintenance of safety and quality of MP foods is a challenging issue among the food retailers. Present study has been planned to analyse the quality of MP foods available in local retail shops. Minimally processed sprouts i.e., green gram and cow pea samples were directly taken from the market and moisture, vitamin C, Total Plate Count (TPC) and Yeast and Moulds (Y&M) were analysed during the shelf life period. Moisture and vitamin C content of sprouted green gram and cow pea on 0, 3rd, 5th day were 61.22±0.15, 60.97±0.02, 60.05±0.01; 56.30±0.02, 55.36±0.14, 54.45±0.32 and 15.07±0.12, 15.70±0.00, 15.80±0.00; 18.47±0.06, 19.10±0.09, 19.70±0.10 respectively. A significant difference in moisture and vitamin C content was observed. Apart from the moisture, stability in vitamin C content was noted which may be due to the proper maintenance of temperature control. Log of colony forming units of TPC and Y&M for green gram and cow pea on 0, 3rd, 5th day were 2.75±1.22, 4.86±3.82, 5.27±4; 2.86±1.33, 3.90±2.01, 4.28±2.88 and 3.77±2.89, 4.47±3.09, 5.02±3.87; 2.85±1.45, 3.87±2.41, 4.25±2.43 respectively. The rapid changes in CFU might be due to improper /poor handling and personal hygiene during the processing and packaging. More technological effort is needed to overcome hurdles in maintaining the quality of MP foods.

Keywords: *Minimal Processing, Sprouts, Microbial Growth, Food Safety*

INTRODUCTION
Minimal processing (MP) is an emerging food processing technology involves deeply into the consumer safety and food quality concerns because technology involves reduced level of processing and the same time increased fresh like quality (Smith, 2011). Minimal processing is defined to include all unit operations such as washing, sorting, trimming, peeling, slicing, coring etc (Ohlsson *et al*., 2002). The reason of minimal processing is to deliver consumers fresh like products with an extended shelf-life whilst ensuring food safety and maintaining sound nutritional and sensory quality (Ohlsson, 1994). Generally a shelf life of about seven days is required for domestic consumption and 7-15 days for overseas consumption. MP products are also called fresh cuts, semi processed, ready to eat and fresh processed foods (Gorris and Tauscher, 1999). Minimal processing is chiefly applicable to fruits and vegetables because these food groups are highly perishable and susceptible to spoilage microorganisms (Perera, 2007). Cleanliness and sanitation are two important factors in quality control and safety of MP food products (Suslow *et al*., 2003).
The market for chilled fresh-cut produce has witnessed dramatic growth in recent years, stimulated largely by consumer demand for fresh, healthy, convenient and additive free foods which are safe and nutritious. The food industry has responded to this demand with creative product development, new production practices, innovative use of technology, and skilful marketing initiatives. Minimally processed sprouts include sprouted green gram, cow pea, soy sprouts, and mixed sprouts. Fresh cut tropical fruits on the market today include melons, cantaloupe, watermelon, mangoes, mangosteen, rambutan, jackfruit, pummel, papaya, durian, grape fruit, pine apples and fruit mixes (Wiley, 1994). Fresh cut vegetables for cooking include peeled carrots, baby corn, broccoli, and cauliflower florets, cut celery stalks, shredded cabbage, cut asparagus, stir-fry mixes and cut sweet potatoes. Consumer interest in international markets towards new or exotic tastes as promulgated growth in the international trade of fresh-cut products

(Lamikanra, 2002). Tropical fresh cut fruits are particularly attractive to young consumers and baby boomers who consume these products as snacks. Manufacturer in many tropical countries have responded to this growing demand by producing fresh cuts for export. Consumers generally purchase fresh cut produce for convenience, freshness, nutrition, safety and the eating experience (Ragaert *et al*., 2004). Consumer demand for these requirements has indeed led to considerable innovations and diversifications in the fresh cut industry. Sprouting is the practice of germinating seeds to be eaten either raw or cooked (Fordham *et al*., 1975). This is a convenient way to have fresh vegetables for salads, or otherwise, in any season and can be germinated at home or produced industrially. This is a prominent ingredient of the raw food diet and common in Eastern Asians cuisines. Sprouting is also applied on a large scale to barley as a part of malting process (Burger and LaBerge, 1985). A potential downside to consuming raw sprouts is that the process of germinating seeds can also be conductive to harmful bacterial growth (Taormina *et al*., 1999). Sprouted grains are outstanding source of proteins, vitamins, and minerals and they contain health driving important nutrients like glucosinolates, phenolic and selenium containing compounds in the brassica plants or isoflavones in the soya bean (Lorenz and D'Appolonia, 1980). The sprouts are consumed at the beginning of the growing phase, their nutrient concentration remains very high (Finney, 1983). Sprouts resides the nutrients, phytochemicals, vitamins, minerals, enzymes and amino acids are of the most importance as these are the most useful in the respect of the human health (Marton *et al*., 2010). Sprouts contain oxygen because sprouts are living food as they contain hundreds of molecules of oxygen which is essential for healthy cells. Oxygen rich foods can ward of viruses and even kill of bacteria (Knighton *et al*., 1984). A fair amount of oxygen rich foods is required in day's diet and sprouts helps to achieve the nutrition balance of the day. Sprouts contains sufficient amount of essential fatty acids where chiefly the body based on their need for functioning (Hsu *et al*., 1980). Sprouts are natural sources of fibre which keeps the digestive system healthy and helps feel fuller between meals eating more fibre can support the healthy diet and reduce the risk of constipation (Zielinski *et al*., 2005). Sprouts contain significant amount of proteins, and can support healthy diet. The market demand for minimally processed foods has undergone rapid expansion, mainly due to busy life styles, increased purchasing power and health conscious consumers. With the busy life styles, increased purchasing power and consumer health conscious, consumer tends to use less time for preparing food. Health conscious consumer prefers eating fruits and vegetables and prefers a ready to eat salad than preparing it themselves. As a result, the maintenance of the quality of minimally processed fruits and vegetables has become more challenging for the manufacturers, retailers and even for consumers. Food safety in ready to eat products, especially raw foods has long been an object for study in order to effectively assess all steps in all minimal processing plant and to analyze the entire food production chain, it is important to identify the origin of the likely contaminants. A number of studies have assessed the microbiological conditions of the ready to eat sprouts; vegetables are available in super markets, street markets, and grocery shops as well as in self service and fast food restaurants (Abadias *et al*., 2008). In light of commercial importance of these food items, including minimally processed raw sprouts, the present study has been designed to determine the quality and safety of minimally processed sprouts available in local supermarkets.

MATERIALS AND METHODS

Materials

Present study was carried out with the market survey, to understand the availability, market demand, and frequency of consumption strategies of minimally processed fruits, vegetables and sprouts in local super markets. Based on the market survey, most frequently used sprouts i.e. green gram and cow pea were selected for the study. The selected sprouts were collected aseptically in sterilized container maintained in cold conditions, delivered to laboratory immediately and physicochemical and microbial quality parameters were carried out.

Estimation of Moisture Content

Weigh accurately 5g of the sample in the moisture dish, previously dried in the oven and weight recorded. Placed the sample dish in the muffle furnace, temperature was maintained 300^{o}c for 4hours. After

completion of burning sample, cool in desiccators and weighed. Repeat the process dry cooling and weighing at 30 min interval time until the difference between the two consecutive weighing is less than one milligram/nil (Ranganna, 19986a).

Calculation

Moisture % by weight = $100(w_1\text{-}w_2) \div w_1\text{-}w_2$

Where

W_1: Weight in (g) of the dish with material before drying

W_2: Weight in (g) of the dish with the material after drying to constant weight

W: Weight in (g) of empty dish

Estimation of Vitamin C

Weigh 3 g of the sample, soaked in metaphosphoric acid solution in a mortar. Grind the sample material to a smooth paste, transfer into a centrifuge tube with sufficient metaphosphoric acid carefully. Centrifuge for 5-10 min at 1000rpm, decant the supernatant into a 100ml standard flask. Transfer the residue to the mortar, grind to paste again adding the metaphosphoric acid again and centrifuge, repeat the extraction process twice. Collect the supernatant into the standard flask and make up to 100ml with metaphosphoric acid. Fill a 100ml burette with the dye solution. Pipette out 10ml of extract in to a conical flask and titrate against dye solution until a faint pink colour persists for approximately 15 seconds. Do a blank with 10ml metaphosporic acid and calculate the vitamin C content of the sample (Ranganna, 1986b).

Microbial Analysis

Total plate count (TPC) and Yeast and Moulds(Y&M) were analysed in two types of sprouts i.e. green gram and cow pea. Growth media varied with the type of microorganisms and need for growth and incubation time and temperature are also varied based on the type strain and its nature. TPC as well Y&M count were analysed with the standard protocols (Brackett, 1987). All analyses were carried out in triplicate and average values were tabulated. Suitable media i.e., Nutrient Agar Media (NAM) and Potato Dextrose Agar (PDA) media were prepared for TPC as well as yeast and moulds (Ranganna, 1986c). Serial dilutions were made to obtain pure cultures, for TPC and yeast& moulds 10^{-7} and 10^{-3} dilutions were taken. From the dilutions 1 ml of the sample was taken for the culture along the duplicate ones. Culture dishes were incubated for 2 days at room temperature. The average number of colony forming units (CFU) from the triplicate plates of the dilutions was calculated.

Statistical Analysis

The results obtained during the evaluation were subjected to appropriate statistical tools to understand the significance between the samples and results were plotted in tables.

RESULTS AND DISCUSSION

Moisture

The moisture content of minimally processed sprouted green gram and cow pea during different storage periods is presented in the table 1. The data in table shows that the mean values of moisture content of minimally processed green gram and cow pea during different storage period i.e. 0 day, 3rd, and 5th day were 61.22±0.15, 60.97±0.02, 60.05±0.01 and 56.30±0.02, 55.36±0.14, 54.45±0.32 respectively. A significant difference was observed in the moisture content of sprouted green gram and cow pea. The results showed that the moisture content of sprouts was decreased during the storage; it might be due to the loss of water content or due to the collapse of injured cells at the cut surfaces or the changes in storage temperatures also may affect the loss of water. Excessive water losses during the storage may result the poor appearance and quality of the product (watada *et al*., 1996).

Vitamin C

Vitamin C content of sprouted and minimally processed green gram and cow pea were presented in table 1. The data in the table shows that the mean values of sprouted and minimally processed green gram and cow pea on 0, 3rd, 5th day were 15.07±0.12, 15.70±0.00, 15.80±0.00 and 18.47±0.06, 19.10±0.00, 19.70±0.00 respectively. A significant difference was observed in the vitamin content of sprouted green gram and sprouted cow pea during storage. Results showed that the vitamin C value of minimally

processed sprouted green gram and sprouted cow pea was increased during storage periods. Temperature management after harvest is the most important factor to maintain vitamin C of fruits and vegetables and sprouts (Lee and Kader, 2000).

Total Plate Count (TPC)

TPC of minimally processed green gram and cow pea during storage periods were tabulated in table no 2 The mean values of total plate count (cfu/gm) of minimally processed sprouted Green gram and sprouted cow pea on 0, 1st, 3rd, 5th day were 566.67±416.63, 73666.67±6658.33, 19000.00±10000.00 and 5686.67±790.27, 29600.00±1209.67, 105000.00±74505.03 respectively. A significant difference was observed in the total plate count during the storage. The reason for increase in TPC might be due to inadequate GMP (Good Manufacturing Practices) and poor processing conditions (Francis *et al*., 1999).

Yeast and Moulds (Y&M)

The yeast and Mould count of minimally processed sprouted green gram and sprouted cow pea is presented in table no 2 and fig 1&2. Mean values of Y&M count of minimally processed sprouted green gram and cow pea during different storage periods i.e. 0, 3rd, 5th day were 726.00±21.63, 8083.33±104.08, 19166.67±763.76 and 716.67±28.67, 7500.00±0.00, 18000±0.00 respectively. A significant difference was observed in the yeast and moulds count during storage. The reason might be due to pre and post harvest contamination, inadequate employee hygiene, temperature, improper handling and processing (Brackett, 1994).

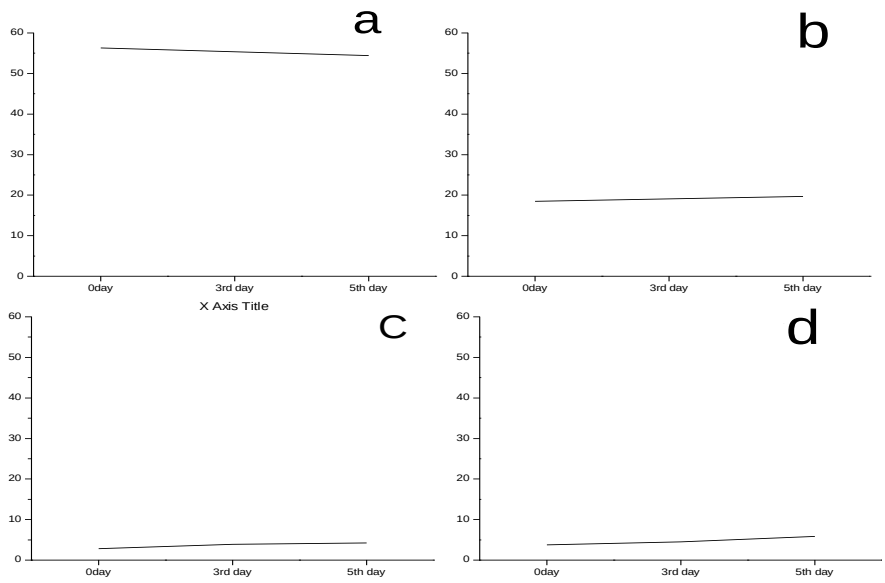
Table 1: Physicochemical analysis of sprouted and minimally processed green gram and cow pea during storage

Quality parameters	Green gram			Cow pea		
	0day	**3rd day**	**5th day**	**0day**	**3rd day**	**5th day**
Moisture*	61.22±0.15	60.97±0.02	60.05±0.01	56.3±0.02	55.36±0.14	54.45±0.32
Vitamin C*	15.07±0.12	15.7±0.00	15.8±0.00	18.47±0.06	19.1±0.00	19.7±0.00

Table 2 Microbial analysis of minimally sprouted and minimally processed green gram and cow pea during the storage

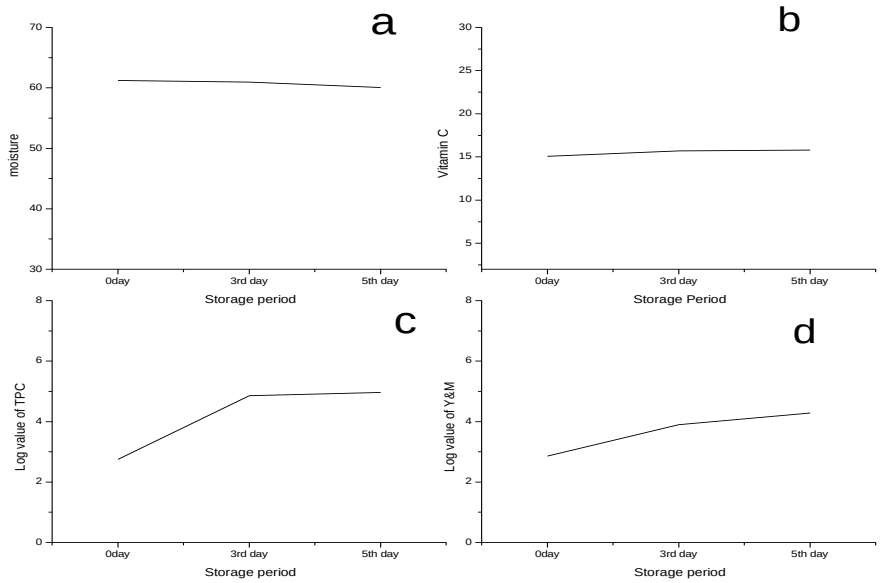
Quality parameters	Green gram			Cow pea		
	0day	**3rd day**	**5th day**	**0day**	**3rd day**	**5th day**
TPC*	566.67± 416.63	73666.67± 6658.33	93000.00± 10000.00	5686.67± 790.27	29600.00± 1209.67	105000.0± 74505.03
Y&M*	726.00± 21.63	8083.33± 104.08	19166.67± 763.76	716.67± 28.67	7500.00± 0.00	18000± 0.00

TPC= Total plate count; Y&M=Yeast and Moulds.



TPC and Y&M count were represented as log of CFU/g

Figure 1: Physicochemical and microbial analysis of minimally sprouted and minimally processed cow pea: (a) Moisture content (b) Vitamin C (c) TPC (d) Y&M for the minimally processed and sprouted cow pea



TPC and Y&M count were represented as log of CFU/g

Figure 2: Physicochemical and microbial analysis of sprouted and minimally processed green gram; (a) Moisture content (b) Vitamin C (c) TPC (d) Y&M

Conclusion

Minimal processing gives additional value to fresh fruits and vegetables rather than other conventional processing methods by means of convenience to eat, easy to handle, ready to prepare and with less/no additives. In the case of sprouts, more attention is needed to preserve freshness and sprouting stage, minimal processing is a well suitable processing method to prepare ready to eat sprouts to preserve long time with fresh like quality. Present study has been carried out to understand and analyse the minimal processing effect in sprouted green gram and cow pea. Quality of minimally processed sprouts was

evaluated by means of physicochemical and microbial analysis. Present study has been concluded that locally available minimally processed sprouts i.e. green gram and cow pea were poor in overall quality. Hence, more attention in processing and minimally processing technologies is needed to take over the challenges and hurdles raises in minimal processing of fruits and vegetables.

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