# Processing and storage stability of bottle gourd (*L. siceraria*) base blend juice

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**Abstract:** Bottle gourd (*Langenariasiceraria*), Aonla (*EmblicaofficinalisGaertn*.), Lemon (*Citrus x limon*) and Ginger (*Zingiberofficinale*) juice was blended in the proportion of 87.90: 23.40: 5.70: 6.00 mL, respectively. Prepared blend juice was hot filled in glass bottles and thermally processed over a temperature range over 80-95$^0$C for 5-30 min. Significant difference was observed in ascorbic acid (vitamin C), total plate counts and, yeast and mould counts ($P$<0.05), while no significant difference was in pH and TSS ($P$>0.05). The best thermal process was found at 85°C hot filling and processing at 85°C for 5 min. At this temperature-time combination, 3.52 pH, 5.17 $^o$Brix TSS, 38.32 mg per 100 mL ascorbic acid, 35 cfu mL$^{-1}$ total plate counts, 2 cfu mL$^{-1}$ yeasts and moulds count, and nil coli form counts of blend juice was obtained. Thermally processed cooled bottles were stored at 37°C for 10 d and 55°C for seven d in incubator for stability test. The t-test indicated that there was no significant difference between the actual and observed values of pH attribute of blend juice ($P$<0.05). At various time and temperatures processed blend juice was very stable and microbiologically safe after their accelerated storage.

**Keywords:** blend juice, thermal processing, storage stability, physicochemical, microbiological

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## 1 Introduction

Bottle gourd (*Langenariasiceraria*) fruit is a good source of vitamin B complex and choline along with fair quantum of vitamin C (Singh and Singh, 2005). Bottle gourd contents 1.6% choline on a dry weight basis; a precursor to acetylcholine, a chemical used to transfer nerve impulses and hence, it is believed to have neurological effects (Thomas, 2008). Bottle gourd contains cucurbitacins, polyphenols and two sterols namely; campesterol and sitosterol (Ghule et al., 2007). Bottle gourd is well known for their immunomodulatory, hepatoprotective, antioxidant, anti-stress, adaptogenic, analgesic, anti-inflammatory, cardio protective, cardio tonic, antihyperlipidemic, diuretic, aphrodisiac, alternative purgative, antidote to certain poisons and cooling properties (Ahmad et al., 2011; Deshpande et al., 2008; Mohale et al., 2008).

Blending of juice is a way of utilization of under-utilized vegetables, fruits, and spices. This may be attributed to change in dietary habits, taste preferences, and the way of life of present-day consumers. During the last few years the demand for blended juice has been increasing. Therefore, to improve the taste, aroma, palatability, storability and nutritive value of bottle gourd juice, it was thought to be convenient to blend it with highly nutritive fruit juices namely aonla and lemon with spice extracts like ginger.

Low thermal processing is an important process enables retaining more color, consistency, fresh flavor, and ascorbic acid content of blend juice products. Preservation of low acid juice for long term storage at an ambient condition; a high thermal processing temperature

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≥121°C is required (James and Shen, 2011). Acidification may convert low acid juice to an acidic juice and allow the use of milder thermal process conditions. To prepare such natural form of low acid juices, it can be blended with aonla and lemon fruits. Both fruits juice have lower pH values and are famous for excellent quality with pleasant flavour, rich in vitamins ‘C’ and minerals. Aonla contains tannin and is a measure of the astringency of the juice while, fruit juice like lemon turns bitter after extraction due to conversion of a chemical compound and hence, processing of fruit juice in it pure form is limited (Goyal et al., 2008; Kristina et al., 2008). Organoleptic quality of blended juice could be increased by the addition of ginger juice having anti-bacterial, anti-fungal properties and act as a good source of natural preservatives (Kalpanaet al., 2008). Ginger blended juices can improve the storability with minimal physicochemical changes (Ghosh et al., 2011).

Therefore, the objective of this work was to determine the minimal thermal processing condition and storage stability for the bottle gourd base blend juice, with the least harm to the vitamins and nutrients.

## 2 Materials and methods

Tender bottle gourd and fresh aonla fruits were procured at the Horticultural Farm, Anand Agricultural University, Anand and, matured lemon(*Citrus x limon*) and ginger rhizomes (*Zingiberofficinale*) were procured at a local vegetable market (Anand, India).

### 2.1 Pre-treatments, juicing and blending

The bottle gourds were cleaned and washed with running tap water. The bottle gourds were sliced in 5 mm using a stainless steel slicer machine (Sumeet). Slices were blanched at 100°C for 3.67 min in water bath having temperature control range between 0-110°C (Electro equipment, New Delhi, India) to inactivate peroxidase enzymes (Silva and Paul,2004). Slices to water ratio was maintained at 1:7 w/v during blanching. Aonla fruits were blanched at 100°C for 6 min and juice was extracted by centrifugal juicer (Rama udyog, Jaipur, India). Lemons were cut into two halves and juice was extracted by squeezing. Ginger rhizomes were sliced and fed into mixer cum grinder for juicing. Final juices were strained through muslin cloth and prepared for blending. Design expert® 8.0.7.1 (Statease Inc., Minneapolis, USA, http://www.statease.com) software; based on numerical technique was used for optimization of the blend juice with the 87.90 ml of bottle gourd, 23.40 mL of aonla, 5.70 mL of lemon and 6.00 mL of ginger juice.

### 2.2 Thermal processing

The optimized blend juice was hot filled at 85°C in 200 mL pre-sterilized opaque glass bottles, crown corked by crown-corking machine and were thermally processed at atmospheric pressure in hot water by immerging bottles into the autoclave (Nova Instruments Pvt. Ltd., Ahmedabad) at 80°C, 85°C, 90°C and 95°C for 5, 10, 15, 20, 25 and 30 min.

### 2.3 Accelerated storage

Thermally processed cooled bottles were stored at 37°C for 10 d and 55°C for seven d in incubator (Khera Instruments Pvt. Ltd., New Delhi) for stability test (Nijhawan, 2012).

### 2.4 Chemicals

Guaiacol (99%) and ascorbic acid standard (99%) were procured from SD Fine Chemicals Mumbai, India; hydrogen peroxide (30%) and sodium bicarbonate (99.5%) from Merck, Mumbai, India; metaphosphoric acid (60%) and sodium salt (98%) from Loba Chemie, Mumbai, India and plate count agar, PDA and VRBA were procured from Hi-Media Laboratories Pvt. Ltd., Mumbai. For all assays, de-ionized distilled water was used.

### 2.5 Measurement of pH and total soluble solids (TSS)

Blend juice pH was measured by using digital pH meter (Systronics India Limited, Ahmadabad, India). The pH meter was standardized before analysis with distilled water having pH 7.0 and standard buffer solution having 4.0 and 9.1 pH. The total soluble solids was measured using pocket hand refractometer-PAL-1(ERMA, Japan) having measuring range 0-53 $^0$Brix.

### 2.6 Determination of ascorbic acid and microbiological values

The ascorbic acid content of blend juice was determined by visual titration method using 2, 6-dichlorophenol-indophenol (Ranganna, 2004). Microbiological values of total plate counts, yeast and mold counts and coli form counts were carried out using standard procedures as described by Ranganna (2004) in sterile environment by using laminar air flow chamber (Khera Instruments Pvt. Ltd., New Delhi).

### 2.7 Statistical analysis

The data obtained (mean ± standard deviation)during the thermal processing experiments were analyzed by BASIC statistical software using, 2-factors four and 6-levels CRD and examined by analysis of variance at 95% confidence level. Storage stability data were analyzed using T-test.

## 3 Results and discussion

### 3.1 Effect of thermal processing on pH of blend juice

Maximum pH observed was 3.52 at 80°C and 85°C for 10 min processing, and minimum were 3.51 at 90°C for 15 and 20 min (Figure 1). pH of optimized blend juice was 3.51 and during thermal processing the variation was 0.01. A significant effect of processing temperature (T) and no significant effect of processing time (PT) on pH of blend juice ($P$>0.05) was noticed (Table 1). However, non-significant interaction indicated the effect was independent and the active acidity in the juice remains very much unchanged. Li et al. (2009) supported result studied changes in quality attributes of longan juice.

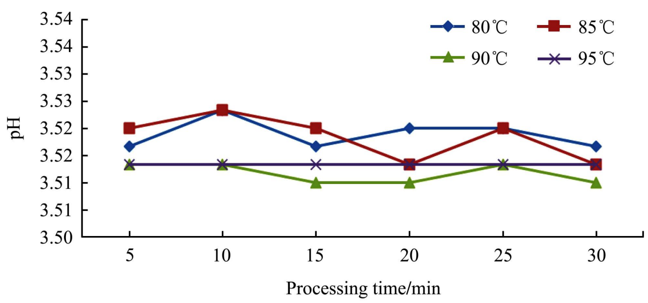


Figure 1 Effect of thermal processing on pH of blend juice

### 3.2 Effect of thermal processing on TSS of blend juice

The TSS of optimized blend juice was 5.13 and maximum variation observed was only 0.10 $^0$Brix after thermal processing (Figure 2). The TSS was significantly affected over the processing temperature (T) at 5% level of probability. The TSS of blend juice was most stable with increase in processing time (PT), though it was not significant. The interaction of both the parameters was found to be non-significant (Table 1).

**Table 1 Statistically mean analyzed data showing effect of varying processing temperatures and time on physicochemical and microbiological quality of blend juice during thermal processing**

| Treatment | pH | TSS /$^0$Brix | Ascorbic acid /mg per 100 mL | Total plate counts /cfu mL$^{-1}$ | Yeast & mould counts /cfu mL$^{-1}$ |
|---|---|---|---|---|---|
| Processing temperature, T | | | | | |
| $T_1$ | 3.5189 | 5.1278 | 38.0672 | 24.6111 | 4.0556 |
| $T_2$ | 3.5183 | 5.1833 | 36.0733 | 16.4444 | 0.6111 |
| $T_3$ | 3.5117 | 5.2278 | 32.7928 | 10.1111 | 0.0000 |
| $T_4$ | 3.5133 | 5.1889 | 30.5400 | 7.1111 | 0.0000 |
| SEm ± | 0.002 | 0.016 | 0.132 | 0.708 | 0.139 |
| CD ($P$=0.05) | 0.006 | 0.047 | 0.374 | 2.013 | 0.395 |
| Processing time, PT | | | | | |
| $PT_1$ | 3.5158 | 5.1883 | 36.8500 | 31.5833 | 2.0833 |
| $PT_2$ | 3.5183 | 5.1883 | 36.0175 | 24.0000 | 1.6667 |
| $PT_3$ | 3.5150 | 5.1750 | 34.9492 | 13.6667 | 1.0833 |
| $PT_4$ | 3.5142 | 5.1917 | 34.1383 | 9.7500 | 1.1667 |
| $PT_5$ | 3.5167 | 5.1750 | 32.7283 | 5.0000 | 0.5833 |
| $PT_6$ | 3.5133 | 5.1833 | 31.5267 | 3.4167 | 0.4167 |
| SEm ± | 0.002 | 0.020 | 0.161 | 0.867 | 0.170 |
| CD ($P$=0.05) | NS | NS | 0.459 | 2.466 | 0.048 |
| Interaction (T × PT) | | | | | |
| SEm ± | 0.005 | 0.040 | 0.323 | 1.735 | 0.340 |
| CD ($P$=0.05) | NS | NS | 0.917 | 4.931 | 0.967 |
| CV, % | 0.23 | 1.35 | 1.63 | 20.62 | 50.51 |

Note: $T_1$=80°C, $T_2$=85°C, $T_3$=90°C and $T_4$=95°C; $PT_1$=5 min, $PT_2$=10 min, $PT_3$=15 min, $PT_4$=20 min, $PT_5$=25 min and $PT_6$=30 min.

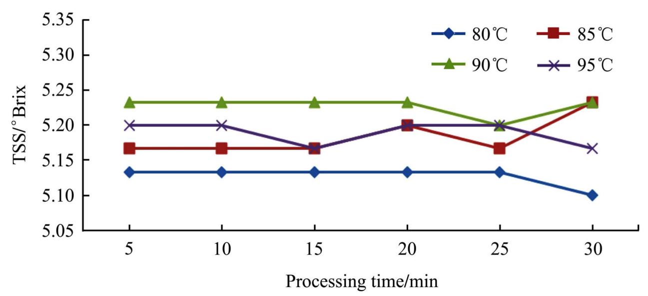


Figure 2 Effect of thermal processing on TSS of blend juice

### 3.3 Effect of thermal processing on ascorbic acid of blend juice

The ascorbic acid content of optimized blend juice was decreased 22.97% and 47.70% at 80°C for 5 min and at 95°C for 30 min, respectively during thermal processing (Figure 3). The remarkably and significant decreased in ascorbic acid was noticed as processing temperature (T) and time (PT) increased indicated both the factor was not governed independently (Table 1). Result revealed that the low temperature long time (LTLT) processing exhibited a higher protective role of ascorbic acid in the blend juice than high temperature short time

(HTST) but prolonging processing time increased the ascorbic acid losses more than the elevation of the processing temperatures. Result supported by Li et al. (2009) studied changes in quality attributes of longan juice.

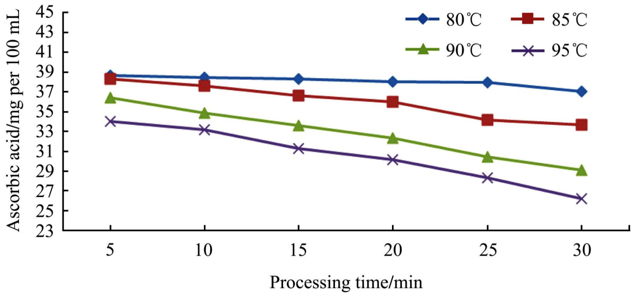


Figure 3 Effect of thermal processing on ascorbic acid of blend juice

### 3.4 Effect of thermal processing on microbiological quality of blend juice

Total plate counts in blend juice was found to be 54, 35, 19, 18 and 7, 4, 2, 1 cfu mL$^{-1}$ at 80°C, 85°C, 90°C and 95°C for 5 and 30 min processing, respectively (Figure 4). Similarly, yeasts and moulds count in blend juice was found to be 7, 2, 0, 0 and 2, 0, 0, 0 cfu mL$^{-1}$ (Figure 5). Total plate counts and yeasts and moulds count in optimized blend juice were 1.4 × 10$^{2}$ and 62 cfu mL$^{-1}$, respectively higher than minimal thermally processed blend juice (Figure 4 and 5). The significant effect ($P$<0.05) was observed for total plate counts indicated that the total plate counts decreased remarkably and significantly as processing temperature (T) and time (PT) increased. Yeasts and moulds count was absent in blend juice processed at ≥85°C for 25 min and their interaction was highly significant at 5% level of significance (Table 1). The coli form counts in optimized blend juice was 87 cfu mL$^{-1}$ and was absent in blend juice processed at ≥80°Cfor 5 min.

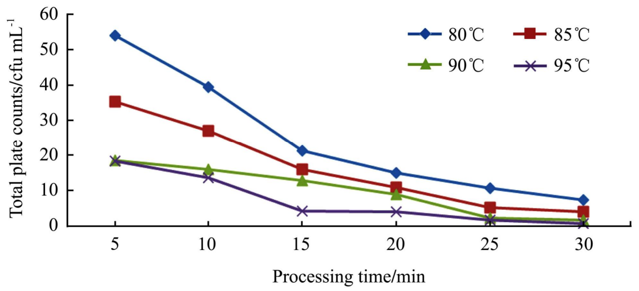


Figure 4 Effect of thermal processing on total plate counts of blend juice

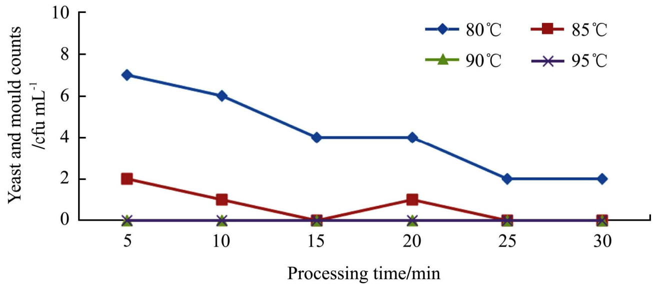


Figure 5 Effect of thermal processing on yeast and mould counts of blend juice

### 3.5 Stability test for thermally processed blend juice

The pH stability test for thermally processed blend juice was carried out at 37°C for 11 d and 55°C for seven d incubation as per food safety standard regulations (FSSRs, 2011) and the mean data are presented in Table 2.

**Table 2 pH stability test for thermally processed blend juice**

| Processing time /min | pH of blend juice | | | t-value$^{@}$ | t-value$^{\#}$ |
|---|---|---|---|---|---|
| | Thermally processed value* | Observed value$^{@}$ | Observed value$^{\#}$ | | |
| Processing at 80°C | | | | | |
| 5 | 3.52 | $3.51^{NS} \pm 0.01$ | $3.53^{NS} \pm 0.01$ | 1.00 | 1.73 |
| 10 | 3.52 | $3.52^{NS} \pm 0.01$ | $3.52^{NS} \pm 0.00$ | 2.00 | 1.00 |
| 15 | 3.52 | $3.52^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 0 | 0 |
| 20 | 3.52 | $3.52^{NS} \pm 0.01$ | $3.52^{NS} \pm 0.01$ | 0 | 0 |
| 25 | 3.52 | $3.52^{NS} \pm 0.01$ | $3.52^{NS} \pm 0.01$ | 0.38 | 0.38 |
| 30 | 3.52 | $3.52^{NS} \pm 0.01$ | $3.52^{NS} \pm 0.01$ | 0.76 | 2.00 |
| Processing at 85°C | | | | | |
| 5 | 3.52 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 0.76 | 0.76 |
| 10 | 3.52 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 2.00 | 1.00 |
| 15 | 3.52 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 2.00 | 2.00 |
| 20 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 0 | 0.50 |
| 25 | 3.52 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 1.00 | 1.00 |
| 30 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 0 | 0 |
| Processing at 90°C | | | | | |
| 5 | 3.51 | $3.51^{NS} \pm 0.00$ | $3.51^{NS} \pm 0.01$ | 1.00 | 0 |
| 10 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 0 | 0 |
| 15 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 1.00 | 0.38 |
| 20 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.52^{NS} \pm 0.01$ | 1.00 | 1.00 |
| 25 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 0 | 0 |
| 30 | 3.51 | $3.52^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.00$ | 1.00 | 0 |
| Processing at 95°C | | | | | |
| 5 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.52^{NS} \pm 0.01$ | 0 | 0.50 |
| 10 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 0 | 0 |
| 15 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.52^{NS} \pm 0.01$ | 0 | 1.00 |
| 20 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 0 | 0 |
| 25 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.51^{NS} \pm 0.01$ | 0 | 1.00 |
| 30 | 3.51 | $3.51^{NS} \pm 0.01$ | $3.52^{NS} \pm 0.01$ | 0 | 0.50 |

Note: * Thermally processed values of blend juice;
$^{@}$Observed values after stability test at 37$^{0}$C for 11 d (mean ± std. deviation);
$^{\#}$Observed values after stability test at 55$^{0}$C for seven d (mean ± std. deviation);
$^{@,\#}$ t-values found non-significant ($P$ < 0.05), t-critical= 4.303 ($P$ < 0.05).

The actual values for the pH attribute of the thermally processed blend juice were compared with the observed values obtained after respective incubation period were analyzed using t-test (Table 2). The t-test indicated that there was no significant difference between the actual and observed values of pH attribute of blend juices ($P$<0.05). This showed that the thermally processed (at various time and temperatures) blend juice were very stable after their accelerated storage.

### 3.6 Optimization

Thermal processing of blend juice at various time and temperatures along with its pH stability test were considered to optimize the process as per food safety and standards rules and regulations (Nijhawan, 2012). The thermal process was optimized on the basis of no changes in blend juice pH after incubation at 37°C and 55°C for 10 and seven d, respectively. The total plate counts not more than 50 cfu mL$^{-1}$ was considered along with maximum retention of quality (ascorbic acid and TSS) in thermally processed blend juice. Based on these process parameters, the best thermal process for blend juice was found at 85°C hot filled and processing at 85°C for 5 min. At this time-temperature combination, 3.52 pH, 5.17$^{o}$Brix TSS, 38.32 mg per 100 mL ascorbic acid, 35 cfu mL$^{-1}$ total plate counts, 2 cfu mL$^{-1}$ yeast and mould counts, and nil coli form counts of blend juice were obtained satisfying the required FSSRs, statistical, physicochemical and microbial criteria.

## 4 Conclusions

Good quality bottle gourd based blend juice could be produced without adding any chemical preservatives in it with minimal thermal processing. During thermal processing minimum and maximum loss of ascorbic acid of blend juice were 22.97% at 80°C for 5 min and 47.70% at 95°C for 30 min, respectively. The product was very stable and microbiologically safe after accelerated storage. The processors will be enabled to produce quality and stable blend juice based on bottle gourd therefore minimizing thermal process for large scale industrial production.

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