Effect of processing treatments on the organoleptic and physicochemical quality of shallot puree upon storage
(Kesan rawatan pemprosesan terhadap mutu nilai rasa dan fizikokimia bawang merah kisar semasa penyimpanan)

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Key words: processing, organoleptic, physicochemical, quality, shallot puree, storage

Abstract
The effects of processing treatments on the organoleptic and physicochemical quality of shallot puree and the possibility of extending its storage life by acidification, heating and chilling methods were studied. Shallot (Allium cepa L.) puree were prepared and subjected to four treatments viz. (a) acidification with citric acid to pH 4.4 and chilled (AC), (b) heated to 60 °C and chilled (HC), (c) acidification with citric acid to pH 4.4, heated to 60 °C and chilled (AHC), and (d) chilled (C). Samples were evaluated at 2-week intervals together with freshly prepared samples. Sensory, pH, total titratable acidity, colour and total volatile oil evaluations were conducted. The AHC treatment allowed shallot puree in aluminium laminate packaging to be kept for 8 weeks. This treatment was better than either acidification or heating alone (under chilled storage), and produced ready-to-use products that were acceptable for cooking. In terms of colour attractiveness, AHC, AC, HC and C treatments gave attractive colour in descending order. Under chilled storage, heating improved colour of samples but acidification was better than heating. Acidification together with heating followed by chilled storage in aluminium laminate bags produced shallot puree with better and comparable colour to fresh shallot puree, up to a shelf life of 8 weeks.

Introduction
Shallot (Allium cepa L.), one of the smaller varieties of the onion family, is a common condiment used in Malaysian dishes for its distinct flavour and aroma. It is used in nearly all local dishes either in sliced, pulped or pureed form. As such, housewives and cooks need to peel the shallots and pound, chop or blend them.

To develop a new product that is convenient for housewives and cooks, processing treatments need to be investigated. Processing accelerates senescence of ready-to-use vegetables especially mechanical damage caused by cutting (Rolle and Chism 1987). This induces considerable stress to plant tissues and stimulates processes and reactions that favour enzymatic browning, alteration of texture and microbial growth. Consequently, browning has been identified as a limiting factor for the storage of diced onion (Brackett 1987).

The availability of hygienic, safe and storable ingredients offers a convenient way for cooking in today’s fast-paced lifestyle.
Mass catering establishments, restaurants and other food outlets and food factories as well as households would definitely welcome the availability of such products in today’s labour scarce economy as this would reduce preparation time for cooking.

Onions are processed commercially into dried products such as powders, fried sliced onions, freeze-dried flakes, pickles, canned whole onions, frozen whole/chopped onions, breaded onion rings, onion flavourings and onion soups (Fenwick and Hanley 1985; Luh and Woodroof 1988; Duxbury 1992). However, these products are not of the same form as those used in Asian cooking.

Work by Blanchard et al. (1996) found that modified atmosphere using 2% oxygen and 10% carbon dioxide was beneficial for the preservation of freshly prepared diced yellow onion and provided a basis for the development of a modified atmosphere pack for optimising the quality of diced onion for 2 weeks at 4 °C. Preliminary studies indicated that freshly prepared shallot puree can only be kept at ambient temperature (28 °C) for 2 days while those stored chilled (4 °C) kept for 2 weeks in aluminium laminated bags (Hasimah 2002). Thus, this study was to evaluate the effects of several processing treatments on the organoleptic and physicochemical quality of shallot puree and the possibility of extending the storage life of shallot puree by these methods.

Materials and methods

Preparation of samples

Shallots were bought from the local market in Kajang, Selangor. Four separate batches (7.5 kg each) were taken from the same lot and each batch peeled, washed and chopped using a bowl chopper grinder (Elektror Muller, Saarbrucken, Germany at Food Technology Research Centre, MARDI) for 1.5 min at room temperature of 28–29 °C. Each batch of shallot puree was given a different treatment, then packed into aluminium laminate bags (180 g each), sealed and kept chilled at 4 °C for a storage duration of 8 weeks.

The four different processing methods used were:

a) Batch 1 was mixed manually with citric acid to pH 4.4 for 3 min at room temperature (AC)
b) Batch 2 was heated in a stainless steel vessel and stirred until a temperature of 60 °C was achieved (HC). This temperature was established in earlier preliminary trials (Hasimah 2002)
c) Batch 3 was mixed with citric acid to pH 4.4 for 3 min at room temperature and heated until a temperature of 60 °C was achieved (AHC)
d) No treatment was given to batch 4 (C)

Samples were taken from each batch at 2-week intervals for evaluation. Fresh samples were also prepared for comparison with the treated samples during each evaluation.

Sensory evaluation

There were three parts to the sensory evaluation of the samples:

a) Multi comparison test for colour and odour
b) Overall acceptability test based on the masak lemak sayur dish prepared using the samples.
c) Ranking test for colour

A total of 25 panellists were involved in the tests and all three tests were conducted at the same session with 10-min intervals between each test.

Multi comparison test for colour and odour was conducted according to the method by Larmond (1977). The colour and odour of the four coded samples i.e. acid + heat + chill (AHC), acid + chill (AC), heat + chill (HC) and chill (C) were compared against a reference sample of freshly prepared puree marked R. Panellists were asked to compare the colour against R and determine if it was more attractive than,
comparable to, or less attractive than the reference. They also had to mark the amount of difference that existed such as none, slight, moderate, much and extreme. This was repeated for each sample.

For odour, panellists were asked to smell one sample at a time and rest in between samples for 1 min. For each sample they were to compare the odour against R and determine if it was stronger than, comparable to, or less strong than the reference. They were then asked to mark the amount of difference that existed by using a tick to the descriptor that best described the difference.

Numerical scores were assigned to the descriptors, using a 9 point scale with scores ranging from 1 to 9, with 1 = extremely inferior colour/weaker odour compared to R; 5 = no difference to R; and 9 = extremely better colour/stronger odour compared to R. This was repeated for each sample and the data statistically evaluated.

A Malaysian dish masak lemak sayur was prepared using the freshly prepared shallot puree and puree from the four treatments at 2-week intervals. The dish consisted of 21.2% long beans, 21.2% cabbage, 3.5% shallot puree, 0.1% black pepper, 17.7% coconut milk and 35.3% water. All ingredients were placed in a pot and cooked for 15 min with medium flame. All panellists were asked to evaluate the overall acceptability of the product using a nine point hedonic rating scale ranging from 1 (extremely dislike) to 9 (extremely like).

Panellists were also asked to rank the four samples together with the fresh reference sample according to the acceptability of the colour of the shallot puree. The most acceptable sample was ranked first, and so on until the sample which was most unacceptable was ranked fifth. The ranks were then converted to scores according to the Fisher and Yates method as described by Larmond (1977). The sample ranked first was given a score of 1.16, second 0.50, third 0, fourth –0.50 and fifth –1.16. The ranking scores were then totalled for each sample and the mean score calculated. The scores were then subjected to analysis of variance.

**pH and total titratable acidity**
The pH value was determined using an Orion pH meter model 410A where three readings were taken and averaged for each sample. Total titratable acidity was determined using 10 g of sample made up to 100 ml with distilled water. After filtering, 10 ml of filtrate was titrated with 0.1 N sodium hydroxide to pH 8.1.

\[
\text{% acidity} = \left[ \frac{\text{Titre} \times \text{factor} \times \text{dilution} \times \text{normality}}{\text{Weight of sample}} \right] \times 100
\]

where a factor of 0.07 was used for citric acid, the reference acid. Two samples were taken from each lot and three analyses were conducted on each sample and the results averaged.

**Colour**
Colour was determined by placing shallot puree in a petri dish to a height of 1.0 cm. Colour was measured using a Chroma meter CR300 (Minolta Camera Co., Japan) based on the CIE 1976 L*a*b* colour system. The equipment was calibrated using a white tile for the Y, x, y values of 92.5, 0.3134 and 0.3194 respectively. A total of 15 colour readings were obtained and the results averaged.

**Total volatile oil**
To determine the total volatile oil, 200 g of sample was extracted for 3 h using simultaneous distillation extraction (SDE) and the volatiles were collected in dichloromethane (Mohammad Nor 1992). The extract was then dried with anhydrous sodium sulphate. The flavour profile of the onion samples was determined using a Hewlett-Packard Gas Chromatograh (HP Model 5890 Series II) coupled directly to a mass spectral detector (HP Model 5971). A bonded phase fused silica capillary column
(HP Ultra 1, 60 m x 2.5 mm x 0.25 µm) was used. Operating conditions used were: injector and detector temperatures at 220 °C and 280 °C respectively; oven temperature was initially kept at 110 °C for 1 min and then programmed to 270 °C for 10 min at the rate of 8 °C/min; mass transfer line temperature was 280 °C; helium carrier gas flow rate was 1.0 ml/min. A data system comprising Wiley library search was used to identify the unknown mass spectrum.

**Data analysis**

For data analyses, the SAS (Statistical Analysis System) program release 8.01 was used (SAS Inst. 2000). The values obtained were tested using Duncan Multiple Range Test. Significance of differences was determined at \( p < 0.05 \).

**Results and discussion**

**Colour evaluation**

Multi comparison test can detect small differences between the sample and the control. It also gives information about the direction and the magnitude of the direction (Larmond 1977). Using this test, it was found that colour of shallot puree was affected by processing treatments and storage time. Throughout the storage period of 8 weeks, AHC samples were better or equivalent to the fresh reference sample, this being indicated by the colour scores which were greater than or equal to 5 (Table 1). AC samples were less attractive than the fresh sample by the 6th week.

At 0 day, AHC sample was similar to AC sample and both samples were also significantly different (\( p < 0.05 \)) from C and HC samples. Mean scores of C and HC samples indicated that they were nearly the same colour as the fresh sample. However, AHC and AC were more attractive than the fresh sample. After 0 day, C and HC samples were not as good as the fresh sample, in terms of colour, with the scores being less than 4. HC samples were significantly more attractive than C samples upon storage (from week 4).

### Table 1. Multi comparison test for colour and odour of shallot puree

<table>
<thead>
<tr>
<th>Storage period (weeks)</th>
<th>Colour</th>
<th>Odour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acid + heat + chill (AHC)</td>
<td>Acid + heat + chill (AC)</td>
</tr>
<tr>
<td>0</td>
<td>6.46 ± 2.50a</td>
<td>6.71 ± 1.94a</td>
</tr>
<tr>
<td>2</td>
<td>5.71 ± 2.35a</td>
<td>6.13 ± 1.76a</td>
</tr>
<tr>
<td>4</td>
<td>5.00 ± 2.00a</td>
<td>3.72 ± 1.24b</td>
</tr>
<tr>
<td>6</td>
<td>5.04 ± 2.11a</td>
<td>3.79 ± 1.77b</td>
</tr>
<tr>
<td>8</td>
<td>5.42 ± 2.18a</td>
<td>4.04 ± 1.54a</td>
</tr>
</tbody>
</table>

Means on the same row with the same letter for each characteristic are not significantly different (\( p < 0.05 \)).
In terms of colour attractiveness, the AHC, AC, HC and C treatments gave attractive colour in descending order. This trend was observed for samples stored from week 4 to 8. Upon chilled storage, either heating or acidification improved colour of samples. However, acidification was better than heating. Acidification together with heating followed by chilled storage in aluminium laminated bags produced shallot puree which was better or comparable in colour to freshly prepared shallot puree up to a shelf life of 8 weeks.

Bernhardt et al. (1986) reported that onion cv. Jubileu when processed into puree with 10% sodium chloride, 500 ppm sodium metabisulphite, acidified to pH 4.1, heated at 92 °C and hot filled into glass packs has a shelf life of 210 days and 90 days when stored at 23 °C and 35 °C respectively. The use of sodium chloride, sodium metabisulphite, higher acid and higher heating temperatures probably allowed for the longer shelf life. The colour of onion paste is significantly affected by both packaging materials and storage temperature (Ahmed and Shivhare 2001).

The ranking test on colour confirms the findings of the multi comparison test. At 0 day AHC is not significantly different from AC and both samples were significantly better \( (p < 0.05) \) than C, HC and fresh samples (Table 2). C and HC were not significantly different from the fresh sample. After 0 day, C and HC were always significantly less attractive compared to the fresh sample, with HC getting higher ranking scores than C. AHC obtained scores that were significantly better or not significantly different to the fresh samples throughout storage. AC samples were significantly different from fresh samples after 6 weeks of storage.

Table 2. Ranking test for colour of shallot puree

<table>
<thead>
<tr>
<th>Storage period (weeks)</th>
<th>Acid + heat + chill (AHC)</th>
<th>Acid + chill (AC)</th>
<th>Chill (C)</th>
<th>Fresh</th>
<th>Heat + chill (HC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.33 ± 0.72a</td>
<td>0.55 ± 0.80a</td>
<td>-0.22 ± 0.67b</td>
<td>-0.23 ± 0.73b</td>
<td>-0.43 ± 0.68b</td>
</tr>
<tr>
<td>2</td>
<td>0.36 ± 0.48a</td>
<td>0.65 ± 0.61a</td>
<td>-0.75 ± 0.53b</td>
<td>0.26 ± 0.79a</td>
<td>-0.52 ± 0.55b</td>
</tr>
<tr>
<td>4</td>
<td>0.72 ± 0.60a</td>
<td>0.27 ± 0.50b</td>
<td>-1.016 ± 0.28d</td>
<td>0.42 ± 0.60ab</td>
<td>-0.40 ± 0.50c</td>
</tr>
<tr>
<td>6</td>
<td>0.64 ± 0.49a</td>
<td>0.12 ± 0.26b</td>
<td>-1.16 ± 0d</td>
<td>0.84 ± 0.43a</td>
<td>-0.44 ± 0.22c</td>
</tr>
<tr>
<td>8</td>
<td>0.75 ± 0.39a</td>
<td>0.10 ± 0.20b</td>
<td>-1.13 ± 0.13d</td>
<td>0.81 ± 0.43a</td>
<td>-0.53 ± 0.13c</td>
</tr>
</tbody>
</table>

Means on the same row with the same letter are not significantly different \( (p < 0.05) \)

Shallot colour deteriorated during storage of the samples. Visual observation of product colour indicated that C and HC samples were dark brown and unacceptable at the 4 fourth week of storage. Darkening of pinkish purple shallot samples to a brown colour was noted when L* and a* values decreased while b* values increased upon increase in storage time (Table 3). Similar observations with respect to L*, a*, b* value changes were also made by Ahmed and Shivhare (2001) on onion paste and Noor Azizah et al. (2005) on shallot puree when they observed degradation of colour of onion and shallot during thermal processing.

Anthocyanin is the major pigment responsible for colour in red onions (Ahmed and Shivhare 2001). Work by Ferreres et al. (1996) found that the content of anthocyanin decreased with storage over 7 days at 8 °C. Degradation of anthocyanin is known to occur in two main ways i.e. oxidation by air and enzymatic degradation by polyphenol oxidase (Ferreres et al. 1996). In this experiment it is probable that heating to 60 °C did not inactivate all the enzymes and thus enabled enzymatic degradation to occur slowly at low temperature storage. Also, the presence of some oxygen in the bags together with the puree probably had a part in the degradation of the anthocyanin.

**Evaluation of total volatile oil and odour**

There was a loss of 12.8% and 70.9% of total volatile oil in heated-chilled shallot.
Processing and quality of shallot puree

Table 4. Total volatile oil content of shallot puree (%) during storage

<table>
<thead>
<tr>
<th>Treatment</th>
<th>0 day</th>
<th>8 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chill (C)</td>
<td>0.0196a</td>
<td>na</td>
</tr>
<tr>
<td>Heat + chill (HC)</td>
<td>0.0057d (70.9%)</td>
<td>na</td>
</tr>
<tr>
<td>Acid + chill (AC)</td>
<td>0.0192b (2.0%)</td>
<td>0.0141a (28.1%)</td>
</tr>
<tr>
<td>Acid + heat + chill (AHC)</td>
<td>0.0171c (12.8%)</td>
<td>0.0083b (57.6%)</td>
</tr>
</tbody>
</table>

Means in the same column followed by the same letter are not significantly different (p <0.05) between treatments throughout the storage period with the mean scores ranging between 4.04 and 5.42 (Table 1). This indicated that the samples were fairly similar in odour in spite of the different treatments given. This could be due to the panellists not being able to detect the differences attributed to the strong odour of the samples as they were not trained for smelling such highly odourous and pungent material.

From the GCMS analysis conducted on the volatile oil obtained, good matching (80–90%) with the chemical database (Wiley Library) was obtained for methyl...
Table 5. Mean scores for overall acceptability of *masak lemak sayur* prepared using shallot puree

<table>
<thead>
<tr>
<th>Storage period (weeks)</th>
<th>Acid + heat + chill (AHC)</th>
<th>Acid + chill (AC)</th>
<th>Chill (C)</th>
<th>Fresh</th>
<th>Heat + chill (HC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6.12 ± 1.60a</td>
<td>6.35 ± 1.24a</td>
<td>6.67 ± 1.13a</td>
<td>6.54 ± 1.02a</td>
<td>6.58 ± 1.18a</td>
</tr>
<tr>
<td>2</td>
<td>6.33 ± 0.76ab</td>
<td>5.96 ± 1.55b</td>
<td>6.38 ± 1.47ab</td>
<td>6.08 ± 1.28b</td>
<td>6.83 ± 0.82a</td>
</tr>
<tr>
<td>4</td>
<td>6.40 ± 1.26a</td>
<td>6.24 ± 0.97a</td>
<td>nc</td>
<td>6.84 ± 1.03a</td>
<td>nc</td>
</tr>
<tr>
<td>6</td>
<td>6.68 ± 1.14a</td>
<td>6.40 ± 0.91a</td>
<td>nc</td>
<td>6.32 ± 1.28a</td>
<td>nc</td>
</tr>
<tr>
<td>8</td>
<td>6.12 ± 1.13a</td>
<td>6.20 ± 1.22a</td>
<td>nc</td>
<td>6.56 ± 1.08a</td>
<td>nc</td>
</tr>
</tbody>
</table>

Means on the same row with the same letter are not significantly different (*p* <0.05)

nc = Cooking trial not conducted due to unacceptable colour of the stored sample

Table 6. pH and total titratable acidity of shallot puree

<table>
<thead>
<tr>
<th>Storage period (weeks)</th>
<th>pH</th>
<th>Total titratable acidity (%) (as citric acid monohydrate)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acid + heat + chill (AHC)</td>
<td>Acid + chill (AC)</td>
</tr>
<tr>
<td>0</td>
<td>4.36a</td>
<td>4.47a</td>
</tr>
<tr>
<td>2</td>
<td>4.34b</td>
<td>4.33b</td>
</tr>
<tr>
<td>4</td>
<td>4.29c</td>
<td>4.30c</td>
</tr>
<tr>
<td>6</td>
<td>4.29c</td>
<td>4.25d</td>
</tr>
<tr>
<td>8</td>
<td>4.29c</td>
<td>4.25d</td>
</tr>
</tbody>
</table>

Means in the same column with the same letter are not significantly different (*p* <0.05)

Trisulphide, dimethyl trisulphide and dimethyl thiopene compounds. These compounds were present in all samples as they are the major compounds, contributing to the shallot flavour and odour. Sulfur-containing compounds in shallots are responsible for the flavour (Chou and Wu 1985; Fenwick and Hanley 1985). Wu and Wu (1981) also found fresh shallot oil to contain dimethyl trisulphide, 1-methylthiopropyl ethyl disulphide, methyl propyl trisulphide, dipropyl trisulphide, propyl propenyl trisulphide and dipropyl trisulphide while Mondy et al. (2002) found that sterilised onions contained dipropyl disulphide, methyl propyl trisulphide and dipropyl trisulphide. Mondy et al. (2002) also observed that different treatments such as freezing, freeze drying and sterilization as well as different varieties gave different profiles of flavour compounds and thus accounting for the different flavours of different processed products.

Overall acceptability test

Results of the overall acceptability test showed that throughout the 8 weeks of storage, products prepared using the AHC and AC samples were not significantly different from those prepared using the fresh samples (*Table 5*). The C and HC samples were not used for the cooking trials after the 2nd week as the samples were visually dark brown and unacceptable.

pH and total titratable acidity

Upon storage of the four batches of samples, pH was found to decrease while total titratable acidity increased with storage time (*Table 6*). pH of acidified samples were between 2.25–4.47 while unacidified samples were between 4.79–5.11. The increase in acidity during storage of products could be due to the samples deteriorating slightly.
Conclusion
Acidification to pH 4.4 together with heating to 60 °C allowed shallot puree packed in aluminium laminate packaging to be kept for 8 weeks under chilled conditions (4 °C). This treatment was better than either acidification or heating alone and produced ready-to-use products that were acceptable for cooking.

Acknowledgement
The authors thank Ms Nazarifah Ibrahim, Ms Khairol Hassan and all who have directly or indirectly contributed to the project implementation. This work was funded by IRPA (Research grant no. 01-03-03-0488).

References
**Abstrak**

Kesan rawatan pemprosesan terhadap mutu nilai rasa dan fizikokimia bawang merah yang dikisar serta kemungkinan kaedah pengasidan, pemanasan dan pendinginan digunakan untuk memanjangkan jangka masa simpanan bawang merah yang dikisar telah dikaji. Bawang merah (*Allium cepa* L.) kisar telah disediakan dan diberi empat rawatan yaitu (a) pengasidan dengan asid sitrik ke pH 4.4 dan disejukdinginkan (AC), (b) pemanasan ke 60 °C dan disejukdinginkan (HC), (c) pengasidan dengan asid sitrik ke pH 4.4, pemanasan ke 60 °C dan disejukdinginkan (AHC), dan (d) disejukdinginkan (C). Sampel dinilai setiap 2 minggu bersama dengan sampel yang baru diproses. Penilaian nilai rasa, pH, jumlah asid titrat, warna dan jumlah minyak merup telah dijalankan. Pengasidan ke pH 4.4 berganding dengan pemanasan ke 60 °C membolehkan bawang merah kisar di dalam pembungkusen aluminium berlaminat tahan disimpan selama 8 minggu dalam keadaan sejuk dingin. Rawatan ini lebih baik daripada pengasidan atau pemanasan sahaja (di bawah penyimpanan sejuk dingin) dan menghasilkan produk siap untuk diguna yang boleh diterima untuk memasak. Berdasarkan warna yang menarik, rawatan AHC, AC, HC dan C memberi warna menarik mengikut tertib menurun. Dalam keadaan penyimpanan sejuk dingin, proses pemanasan atau pengasidan boleh meningkatkan warna sampel tetapi pengasidan memberi warna yang lebih baik daripada pemanasan. Pengasidan berganding dengan pemanasan diikuti dengan penyimpanan sejuk dingin di dalam beg aluminium berlaminat menghasilkan warna bawang merah kisar yang lebih baik ataupun setanding dengan bawang merah kisar yang baru diproses hingga minggu ke-8 penyimpanan.

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