

RESEARCH PAPER

DOI: 10.15740/HAS/IJPPHT/6.2/150-156

# Vinegar production from cashew apple

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■ Research chronicle : Received : 29.01.2015; Revised : 19.10.2015; Accepted : 21.11.2015

## SUMMARY :

Cashew apple weighing 8-10 times that of nut is a pseudo fruit formed by the swollen receptacle and is highly nutritious. It is a valuable source of sugars, minerals and vitamins. The annual production of cashew apple in our country is estimated to be around 60 lakh tons, major quantity of which is being wasted. Technologies have been standardized for the removal of tannin as well as for the preparation of many value added products from cashew apple at Cashew Research Station, Madakkathara under Kerala Agricultural University, Thrissur. Cashew apple is highly perishable and gets fermented easily. A trial was conducted at Cashew Research Station, Madakkathara to standardize the method for the preparation of vinegar from cashew apple. Vinegar could be prepared by alcoholic and subsequent acidic fermentation of the juice in 3 weeks' time. There were six treatments with ingredients like sago, ammonium sulphate, citric acid etc. The sample with cashew apple juice (1 litre), sugar (80g) and yeast (1g) along with mother vinegar (3 litre) had the acidity of 4.66 per cent which was rated the best treatment for cashew apple vinegar production. The selected technology was further standardized for large scale production of vinegar to take up continuous production on commercial basis.

**KEY WORDS :** Vinegar production, Cashew apple

**How to cite this paper :** Sobhana, A. and Mathew, Jose (2015). Vinegar production from cashew apple. *Internat. J. Proc. & Post Harvest Technol.*, 6 (2) : 150-156.

Cashew (*Anacardium occidentale* L.), a major commercial crop of India, is mainly cultivated for its nut. It is popularly known as the 'poor man's crop' and 'rich man's food' (Bhoodes, 2014) and is the 'Gold mine' of wasteland. India is the largest processor and consumer of cashew occupying an area of 9.8 lakh ha (Hubbali, 2013). The nut which is kidney shaped, is the real fruit of cashew while the apple attached to it, is the juicy swollen peduncle. Cashew apple, which weighs about eight times that of the nut, is very attractive due to its striking colours and is highly nutritious. With a current

annual cashew nut output of 7.28 lakh tons, cashew apple production in our country is estimated as 60 lakh tons per annum; of which very little is consumed either as fresh fruit or in few cases processed into drinks or pulp, the rest gets wasted; because of the perishable nature (Mathew *et al.*, 2013). In Goa, it is profitably used for the production of *feni*. Akinwale *et al.* (2001) reported that cashew apple juice had the highest vitamin C content (203.5 mg per 100g) when compared to other common fruit juices. The high tannin content makes it a suitable remedy for sore throat and chronic dysentery in Cuba

and Brazil (Morton, 1987). It is also reported to have anti-bacterial properties. The people of Kerala use cashew apple for many stomach ailments. Ripe apple is very juicy and spongy having a unique flavour and smell. The astringent and acid principles in cashew apple produce a rough unpleasant and biting sensation on the tongue and throat, major drawback of the fruit which prevents the consumption of fresh fruits (Attri, 2009; Narayanankutty and Augustine, 2009 and Sobhana *et al*, 2013). Thiripurasundari and Usharani (2011) have reported the successful production of vinegar with an acidity of 5.9 to 6.7 per cent from cashew apple juice. A number of technologies have been developed by Kerala Agricultural University for the economic utilization of cashew apple. In continuation of that an experiment was conducted to find out the feasibility of the production of vinegar from cashew apple at Cashew Research Station, Madakkathara under Kerala Agricultural University.

## EXPERIMENTAL METHODS

Fully ripe, firm and good quality apples were collected from the field after discarding the damaged and injured/infected apples. The selected fruits were thoroughly washed in water and the juice extracted by using the juice expeller and strained through a muslin cloth. This juice was used for the preparation of vinegar. Cashew apple vinegar was prepared from cashew apple juice by adding sago, sugar, ammonium sulphate, citric acid and yeast along with mother vinegar and there were six treatments. Vinegar preparation consisted of two stages, alcoholic fermentation and acetic fermentation. The treatments given for the first step in vinegar production, *i.e.*, alcoholic fermentation, are listed in Table A.

Boiled the sago in a little quantity of water and cooled, then added to the extracted juice kept for 3 hours for clarification of juice (removal of tannin). Then sugar was

added to the clarified juice, strained and the juice was boiled and cooled, followed by adding citric acid and ammonium sulphate and yeast (*Saccharomyces cerevisiae*). In sample-5, citric acid and ammonium sulphate were not added. The citric acid was added as a clarifying agent and ammonium sulphate as a bleaching agent. After adding all the ingredients the samples were kept for 7 days in narrow mouthed plastic bottles with cotton plugging. Alcoholic fermentation occurred and after one week the alcoholic ferment was seen at the top and tannin below. The supernatant juice was filtered to get the alcoholic ferment and the settled yeast and tannin were removed.

At this stage mother vinegar was added @ three times the quantity of alcoholic ferment for commencing the acetic fermentation. Again kept for two weeks for acetic fermentation in wide mouth glass containers. The mother vinegar contains the live *Acetobacter aceti* bacteria, which acts on the alcoholic ferment and converts the alcohol to acid. After two weeks the samples were filtered and the samples were pasteurized by double boiling at 70-80°C for 10 minutes and acidity was checked.

### Refinement of cashew apple vinegar :

The cashew apple vinegar was found to have a dark brown colour; hence, trials were conducted to reduce the intensity of colour to the extent possible.

### Addition of sago :

This trial was carried out after obtaining the result of the first experiment detailed above, wherein, sample 5 was selected as the best treatment for vinegar production from cashew apple. Hence, treatments were fixed using ingredients of sample 5 along with different quantities of sago and the procedure employed was the same as detailed above. Different quantities of sago were added

Ingredients	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Cashew apple juice	1lit.	1 lit.	1lit.	1lit.	1lit.	1lit.
Cooked sago	5 g	5g	5g	5g	5g	5g
Sugar	160 g	140 g	120 g	100 g	80 g	40 g
Ammonium sulphate (g)	1g	1g	1g	1g	-	1g
Citric acid	2g	2g	2g	2g	-	2 g
Yeast (kept in 10ml lukewarm water for half an hour)	1g	1g	1 g	1 g	1 g	1 g

Kept for 7 days in narrow mouthed plastic bottles with cotton plugging

Ingredients	Sample 1	Sample 2	Sample 3	Sample 4
Cashew apple juice	1 lit.	1 lit.	1 lit.	1 lit.
Sugar	80g	80g	80g	80g
Cooked sago	5g	10g	15g	20g
Yeast	1g	1g	1g	1g

Kept for 7 days undisturbed in wide mouthed glass bottles with cotton plugging

Ingredients	Sample 1		Sample 2		Sample 3		Sample 4	
	1a	1b	2a	2b	3a	3b	4a	4b
Alcoholic ferment	500ml	500ml	500ml	500ml	500ml	500ml	500ml	500ml
Mother vinegar	1.5 Lit.	1.5 Lit.	1.5 Lit.	1.5 Lit.	1.5 Lit.	1.5 Lit.	1.5 Lit.	1.5 Lit.
Sago	-	2.5g	-	5.0g	-	7.5g	-	10.0g

The samples were kept aside for two weeks and acidity was checked.

Ingredients	Sample 4a				Sample 4b			
	1	2	3	4	5	6	7	8
Vinegar	200ml	200ml	200ml	200ml	200ml	200ml	200ml	200ml
Chitosan	1g	2g	3g	4g	1g	2g	3g	4g
Gelatin	0.1g	0.2g	0.3g	0.4g	0.1g	0.2g	0.3g	0.4g
PVP	0.3g	-	-	-	0.3g	-	-	-

The samples were kept aside for two weeks and noted the colour variation, if any.

initially during the process of alcoholic fermentation as listed in Table B.

After the alcoholic fermentation, again different concentrations of sago were added to the alcoholic ferment along with the required quantity of mother vinegar and kept for acetic acid fermentation Table C.

#### *Chemical treatment :*

After checking the acidity, it was seen that samples 4a and 4b were found to have the minimum acidity required for vinegar but the colour was dark. Hence, another trial was carried out using chemicals to find their effect on colour. Here the prepared vinegar after pasteurization was used for the addition of chemicals such as gelatin, PVP (Poly Vinyl Pyrollidone) and chitosan. The details are given in Table D.

#### **Sensory evaluation :**

The samples 2, 4, 5 and 6 listed in Table A were selected for the sensory scoring since these samples had the minimum acidity required for the vinegar. The organoleptic scoring was done using the vinegar in the fresh salad prepared with cucumber, carrot and cabbage, 20g each. The samples were subjected to sensory scoring

with five point hedonic scale as suggested by Lindaposte *et al.* (1999). The organoleptic evaluation of the salad with vinegar was carried out among selected 10 members who were asked to give score for various parameters like appearance, colour, flavour, taste, texture, saltiness, and overall acceptability and data tabulated. Data collected from organoleptic studies were subjected to statistical analysis. Kendall's co-efficient of concordance was used to assess the degree of agreement among the 10 judges.

## EXPERIMENTAL FINDINGS AND ANALYSIS

Many researchers have reported that cashew apple can be utilized for the preparation of different non fermented and fermented products *viz.*, juice, syrup, jam, candy, chutney, pickle, wine, liquor, brandy, vinegar etc. (Vijayakumar, 1991). Silva *et al.* (2007) reported the production of wine from cashew apple, a fermented product. According to Mini *et al.* (2008) cashew apple can be successfully utilized for the production of wine.

The data on acidity of different samples of vinegar produced by adding different concentrations of ingredients during alcoholic fermentation as per Table A are presented

in Table 1.

It is noticed that the acidity ranged between 4.32 and 6.63, depending upon the treatments. Among the six samples, sample 6 had the minimum acidity of 4.32 per cent after pasteurization followed by sample 5 with an acidity of 4.66 per cent. Sample 5 prepared with cashew apple juice (1.0 lit.), sugar (80 g) and yeast (1g) along with mother vinegar (3.0 lit.) had the acidity of 4.66 per cent where no chemicals were added during the preparation. But in sample 6, chemicals like ammonium sulphate and citric acid were added. Hence, sample 5 with cashew apple juice (1 lit.), sugar (80g) and yeast (1g) along with mother vinegar (3.0 lit.) which had the acidity of 4.66 per cent could be accepted for cashew apple vinegar preparation. Silva *et al.* (2007) reported the successful production of cashew wine by alcoholic fermentation of peduncle juice. Acetic fermentation was reported to be the next step after alcoholic fermentation, where the alcohol molecules got oxidized to acid molecules by the action of *Acetobacter aceti* bacteria (Tsfaye *et al.*, 2002). This leads to the production of vinegar. In the present trial, the mother vinegar contains the live *Acetobacter aceti* bacteria, which acts on the alcoholic ferment and converts the alcohol to acid.



Fig. 1 : Different samples of cashew apple vinegar

Vinegar is the product of microbial oxidation of ethanol consisting substrate to acetic acid (Thiripurasundari and Usharani, 2011). In the first step of vinegar preparation, the yeast breaks down the sugar in cashew apple to ethyl alcohol, and then the acetic acid

bacteria present in the mother vinegar acts on this alcohol and convert it to acid. Acetic acid bacteria are a group of anaerobic gram negative bacteria which have the ability to oxidize ethanol to acetic acid. The high content of sugar in cashew apple makes the fermentation easy. According to Yamagishi *et al.* (1998) natural vinegar is a superior food additive over synthetic vinegar as it carries essential amino acids from its fruit sources and is reported to act as a medicine for aches and gastric troubles. In this experiment the vinegar could be successfully produced from a natural fruit high in vitamins and minerals and having good medicinal value. Another advantage is that cashew apple is a wasted fruit unlike other commonly consumed fruits thus paving the way for the economic utilization of the fruit in a better manner. Tewari *et al.* (1991) reported that the high content of sugar in cashew apple makes it suitable substrate of choice for natural vinegar. Successful preparation of various value added products from cashew apple like juice, *fenny*, wine, dried cashew apple, syrup and jam has been reported by Suganya and Dharshini (2011). Thiripurasundari and Usharani (2011) have reported the successful production of vinegar with an acidity of 5.9 to 6.7 per cent from cashew apple juice by using adsorbed (bagasse, corn cobs and wood shavings) and entrapped (calcium alginate) cells of *Acetobacter aceti* MTCC-2975.

Even though the acidity of the vinegar obtained was between 4-5 per cent, as required for the vinegar produced from fruits, the colour of vinegar was dark, which is suspected to affect the acceptance. Usually the vinegar prepared from fruits has a dark colour compared to the synthetic vinegar which is the pure chemical, acetic acid.

An attempt was made to reduce the colour to the extent possible, by adding various concentrations of sago during the alcoholic fermentation. Sago was used because in cashew apple the removal of tannin is being practiced using sago, as suggested by Mini and Mathew (2008). Being a polyphenol, the tannin content in cashew apple makes the product dark coloured. Hence, more quantity

Table 1: Acidity in cashew apple vinegar produced by adding different concentrations of ingredients during alcoholic fermentation

Samples	1	2	3	4	5	6
Acidity after pasteurization (%)	6.63	5.15	5.64	5.16	4.66	4.32

Table- 2: Acidity in cashew apple vinegar produced by adding different concentrations of sago during alcoholic fermentation

Samples	1a	1b	2a	2b	3a	3b	4a	4b
Acidity after pasteurization (%)	6.60	6.78	6.0	5.58	5.28	5.16	4.08	4.68

of sago was tried for finding their effect on colour.

### Refinement of cashew apple vinegar :

The data on acidity of different samples of vinegar after adding more quantity of sago during alcoholic fermentation are presented in Table 2.

Among the 4 samples, sample 4a had the minimum acidity of 4.08 per cent after pasteurization followed by the sample 4b with an acidity of 4.68 per cent. In sample 4a there was no additional sago added during alcoholic fermentation. There was no variation in the intensity of colour among any of these samples. Hence, from these samples, 3a, 3b, 4a and 4b were again selected for chemical treatment as detailed in Table D. By the addition of chemicals to the vinegar, it was found that only gelatin added samples showed a slight reduction in the colour, which could not be taken as an apparent change.

It is a common practice to use vinegar in the green salads for improving the taste. Hence, sensory scoring of salad prepared using the cashew apple vinegar was done. Sensory evaluation was done with the four samples, viz., 2, 4, 5 and 6 obtained from the first trial for vinegar production and the results are presented in Table 3. Since the refinement trials did not yield any good result, the samples of the first trial having the minimum acidity were selected for the organoleptic scoring.

It is clear that the salad 5 prepared with cashew apple juice (1 lit.), sugar (80 g) and yeast (1g) along with mother vinegar (3.0 lit.) which had the acidity of 4.66 per cent, showed maximum acceptability among the selected judges. Thus, this sample could be regarded as the best sample in cashew apple vinegar production.

### Small scale production unit for cashew apple vinegar:

The selected technology was further standardized for continuous production of vinegar so that vinegar can

be taken regularly. The procedure is briefed hereunder.

### Alcoholic fermentation :

Alcoholic ferment was prepared as described hereunder. Mixed one litre of cashew apple juice with 80 g sugar and boiled. After cooling, added 1g instant yeast (dissolved in lukewarm water). Mixed and kept in food grade plastic can for 7 days. Mouth of the can was tied with a muslin cloth. After 7 days, clear juice on the top was taken as alcoholic ferment. In this way large quantity of alcoholic ferment was prepared for pouring to the vinegar production vessel continuously.

### Acetic fermentation :

The production was effected in a food grade plastic bucket of 100 lit. capacity with perforated lid and having a PVC pipe of 1" diameter pierced through the lid with a bent at the bottom end. A funnel was kept at the top of the PVC pipe for pouring the alcoholic ferment. A tap was fixed at a height of 40 lit. from the bottom on the bucket for collecting the vinegar at regular intervals. In this 100 lit. container, 30 lit. mother vinegar having minimum 4 per cent acidity was poured as starter culture along with 10 lit. alcoholic ferment. Alcoholic ferment was added through a funnel, without opening the lid of the container. After one week, the acidity was checked and if it was below 5 per cent, then added 10 lit. of the alcoholic ferment. Like this, adding of alcoholic ferment continued as 15 lit. alcohol during 3<sup>rd</sup> stage and 15 lit. at 4<sup>th</sup> stage after checking the acidity (<5%), without disturbing the top gel layer, which was formed by acetic bacteria. In the final stage there was a total quantity of 80 lit. in the plastic bucket. After 4<sup>th</sup> week the acidity was again checked and if found to be 4-5 per cent, the vinegar could be taken through the tap provided at one side of the plastic bucket. This vinegar was double boiled at 70-80°C for 10 minutes and kept as such for 3 weeks

Table 3 : Sensory scoring of salad prepared using different vinegar samples

Samples	Appearance	Colour	Flavour	Taste	Texture	Saltness	Acidity	Overall acceptability
2	2.70	2.45	2.45	2.40	3.10	2.05	2.35	2.70
4	2.20	2.35	2.35	2.20	2.15	2.55	2.40	2.20
5	3.05	2.65	2.30	2.90	2.65	2.70	2.65	3.05
6	2.05	2.55	2.90	2.50	2.10	2.70	2.60	2.05
Kendalls W (a)	0.192	0.045	0.079	0.070	0.283	0.098	0.029	0.192
Assumption significance	0.123	0.714	0.500	0.550	0.037	0.400	0.833	0.123
Significance	1.23	7.14	5.00	5.50	0.37	4.00	8.33	1.23

in air tight containers. Then decanted to remove the settled bacteria and filled in bottles and sealed.



Fig. 2 : Production unit for cashew apple vinegar

### Conclusion :

The use of cashew apple as a raw material for a variety of fruit based products has been well established, which can trigger revolution in cashew industry. An addition to the list is the vinegar from cashew apple. Vinegar is the acetic acid which is largely used for the preparations like, pickles, salads, etc. and usually synthetic vinegar is the available vinegar in the market. Fermentation technology is adopted for the preparation of vinegar from fruits and other plant produces. Cashew apple, a natural pseudo fruit, gets easily fermented and is high in sugar content; utilizing these qualities vinegar production becomes easy. Research result of Cashew Research Station, Madakkathara under Kerala Agricultural University, Thrissur, shows the potential of making vinegar from cashew apple. Vinegar prepared with cashew apple juice (1 lit.), sugar (80 g) and yeast (1g) along with mother vinegar (3.0 lit.) which had the acidity of 4.66 per cent was rated as the best treatment for cashew apple vinegar production. The technology gives immense scope for income enhancement from cashew plantations, where in, the majority of cashew apple is being wasted which becomes a nuisance in the field.

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