IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB)
ISSN: 2455-264X, Volume 4, Issue 4 (Jul. – Aug. 2018), PP 05-17
www.iosrjournals.org

Waste Utilization ByBiotransformation of *Carica Papaya Linn* Peels And Development Of A Value Added Product From Obtained Byproducts: An Organoleptic And Biochemical Approach

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Abstract:*The diverse agro- climatic zones make India as the second largest producer of fresh fruits and vegetables granting processed fruit and vegetable products such as juices, preserves etc. to number alongthat leads to generation of large amounts of wastes, both solid and liquid. This waste is incautiously being thrown without any treatment promoting environmental deterioration. However, these wastes hold immense potential nutritionally; functionally as well as physico-chemically which can be utilized for producing cheaper value added ingredients that bear economic benefits.*

Carica papaya Linn is a wholesome fruit, widely known as "the Fruit of Angels", serves as an ideal, low cost food. It ranks second as a source of beta carotene and is an excellent source of natural sugars, vitamin C, and potassium, with fair amounts of calcium and phosphorus. Low in calories, this exotic fruit holds immense medicinal value since ancient timesfor treating innumerable disorders and conditions like toothache up to theprevention of cancer.

To substantiate the potential of fruit wastes, proximate profiles of papaya peel were analyzed using bench science experiments. Following analysis, the peels were then bio valorized to procure commercially important acetic acid which in its own holds several health benefiting attributes.Further in order to project the organoleptic appeal of the fruit vinegar under study, invasive and non-invasive sensory evaluation was carried out by a semi-trained panelist.This was executed with a recipe. The data was subjected to biostatistical analysis which proved that the novel recipe was highly appreciated.Critical control points were established during the process of novel product development and hazard analysis at critical control points was carried out.The commercial appeal of the recipe was also speculated using value for money (VFM) studies.Future prospects include determination of anti- nutrients and anti-microbial activity of vinegar. The use of this waste utilized novel product as a functional food and development of novel products keeping in mind the nutritional profile and organoleptic acceptance needs to be explored.

Keywords:*Carica papaya Linn, Fruit vinegar, HACCP, Novel Product Development, Nutraceutical food, Papaya peels, Sensory Evaluation, VFM, Waste utilization.*

Date of Submission: 22-08-2018 Date Of Acceptance: 04-09-2018

I. Introduction

Food; the cradle for human sustenance; appeals to the senses, nourishes the body and satiates the soul.Food is not just a medium of nourishment, but also a mode of elevating the physical, emotional and spiritual quotient of an individual, thereby acting as the epicenter of human living. Fast paced lifestyles, hectic schedules and workaholic cultures have made our ability to make healthier food choices plummet to a great extent. Sedentary lifestyles have kindled the spectrum of nutrition from balanced diets to more convenient, but imbalanced diets. Therefore, emphasis on quality nutrition is need of the hour.

To somewhat address this problem; a new trend of convenience foods has evolved. Convenience foods greatly reduce the time required in procuring, processing and preparation of foods, thusare poised on the fulcrum of consumer convenience. However, this manufacturing initiative may be considered as a double edged sword. Albeit the boons of extended shelf life, novelty to unfamiliar ingredients, great exposure to non-indigenous cuisines etc. have been made possible through processing operations, the bane of inception of wastes, both solid and liquid, which is incautiously been discarded in environs cannot be neglected. These

wastes constitute untapped sources of valuable compounds which can actas functional ingredients in enrichment of pre-existing products or development of a novel product as a whole.

Fruits among theconjoined twins, viz fruits and vegetables, are often considered as the 'perfect foods' due to their high fiber content and raw consuming ability. Papaya is one such wholesome fruit popularly known to be carotene-rich, full of antioxidants, contributing for the treatment of innumerable aliments. Papaya finds application in food industry asvegetable, pickles, candy, jam, jelly etc.The unexplored parts of papaya fruit include its seeds and the peel which are oft discarded.The following research attempts to unfold the untapped potential of fruit and vegetable byproducts by utilizing them to develop a novel nutritional product thus providing cheaper but value added ingredients through diverse frameworks of biochemical analysis, sensory evaluation, HACCP along with others.

About Papaya(Carica papaya Linn):

The Chinese saying, *"The papaya is the fruit of a long life"*, rightly upholds the reputation of the fruit to be a knockout when it comes to its vital ingredients - vitamins, minerals, trace elements, enzymes and much more! This therapeutically valuable plant, scientifically known as *Carica papaya Linn*, falls under the family Caricaceae with related species as *Carica stipulate*, *Carica pentagona* and *Carica pubescens*. Historically considered as an exotic fruit, Papita (local name for papaya in India) is now being produced at a staggering 4.2 million metric tons, accounting for 35 percent of the world's production.

Varieties of papaya:

There are numerous strains and varieties of this melon-like fruit and the variation in size, form and colour is greatly immense. Only a few true cultivars of pawpaw exist on account of its complex genetic make-up.Improvement of cultivars is directed toward high yielding, fitness for export, good texture of flesh, high sugar content, intermediate fruit size, same cavity, and uniformity and resistant to pest and diseases. Some varieties of papaya are **Coorg Honey Dew, Pusa Dwarf, Giant Majesty, Delicious, Dwarf; CO.1, 2, 3 ,5; Washington;Solo; Ranchi**; **IIHR39 and IIHR54; Taiwan-785, 786**etc.

Papayas are spherical or pear-shaped fruits with flesh that is rich orange in color with either yellow or pink hues.With an undeniably tropical flavor, papaya provides an understated, mellow sweetness. Its texture is gorgeously dense, rich and creamy like a butterfruit. It ranks second only to mango as a source of beta carotene and is an excellent source of natural sugars, vitamin C, potassium and also contains fair amounts of calcium and phosphorus as well. Papaya peels often discarded as wastes and/or find application in cosmetic industry have a tremendous scope of being biotransformed into cheaper functional ingredients in food products as well.

II. Review Of Literature

A detailed and exhaustive review of scientific literature highlights the following aspects of Papaya as a research endeavor:

1. Numerous comprehensive studies on showcase that*Carica papaya Linn* is an economically and culturally important fruit tree proving valuable for professionals involved in both research as well as commerce.
2. Though the fruit holds maximum nutritional value as rich sources of antioxidant nutrients such as carotenes, vitamin C and flavonoids; the B vitamins, folate and pantothenic acid; and the minerals, iron, calcium, potassium, copper, and magnesium; and fiber, the leaf and seed account for good amount of carbohydrates while stem accounts good amount of protein as well.
3. The extracts of C. papaya contain terpenoids, alkaloids, flavonoids, carbohydrates, glycosides, saponins, and steroids along with numerous enzymes namely Papain (digestive enzyme), Chymopapain (anti-inflammatory), Carpaine (anti-hypertensive), Lycopene (anti-cancer), Fibrin (anti-clotting).
4. Papaya is well known for its myriad scientifically proven therapeutic properties. Some of which include anti-fertility, diuretic, anti-helminthic, wound healing, antifungal, antibacterial, antitumor, anti-oxidant, laxative, anti- sickling, and nephro protective.
5. Papaya peel is often used in cosmetics and in many home remedies as a sunscreen, soothing slave, pain relieverand muscle relaxant. Habitually discarded as waste, papaya peel constitute high contents of protein and fiber and therefore can be used as alternative sources of nutrients and can also be added in foods avoiding waste and adding value to the fruit.
6. Current studies with papaya peels are only confined to extraction of pectin without its usage in food industry. One study successfully attempted fortification of cookies with papaya peels flour which indicated improvement in its nutritional characteristics in comparison to its ordinary counterpart.
7. In a study executing bioconversion of certain selected vegetable and fruit peel wastes in viable product, alcohol and biomass, ascertained maximum production of alcohol within 36hrs of fermentation in papaya peels extract with highest productivity of biomass 0.83g/l/h for papayapeel extract after 48h of incubation indicating practicality of utilization of wastes.

8. A research endeavor highlighted a methodology of recycling peel waste rather than its careless discharge which brings a lot of environmental issues bybio converting of papaya peel waste into vinegar using *Acetobacter aceti*. The results yielded 8.11% of alcohol content and titrable acidity as 5.23% rendering scope of deploying discarded peel into food by converting it into therapeutically important vinegar.
9. Therapeutic effects of vinegar arising from consuming the inherent bioactive components including acetic acid, gallic acid, catechin, ephicatechin, chlorogenic acid, caffeic acid, p-coumaric acid, and ferulic acid cause antioxidative, antidiabetic, antimicrobial, antitumor, antiobesity, antihypertensive, and cholesterol-lowering responses.
10. Vinegar is largely produced in the cottage scale or in traditional sectors. Presently only synthetic vinegar is being produced. Natural fruit vinegars are nutritive, appealing and has a huge market demand thereby presenting a wider scope of waste utilization and environmental indemnity.

III. Aims And Objectives

- The main aim of this study is to bio valorize papaya peel, an agro- industrial residue, into a value added product via effective utilization with the view of environmental management.
- To develop a functional/ health food/ nutraceutical as an alternative system of medicine to benefit mankind through wellness management.
- To conserve the environment by recycling fruit peel waste and thereby generating financial revenue from waste.
- A minor yet significant attempt to find an alternative solution over orthodox medicine through natural panacea.

The above said aims were accomplished through the said objectives:

- To exploit the nutritive potential of papaya peels via bioconversion of nutrient rich papaya peels to commercially important acetic acid (vinegar).
- To carry out proximate analysis in order to study its constitutive nutritional properties of both peels and vinegar.
- To assess sensorial and organoleptic attributes via expert sensory panel.
- To develop a nutritionally enhanced and standardized novel product from obtained vinegar.
- To evaluate nutritional, sensorial & organoleptic attributes and keeping quality of the developed novel product in order to underline the socio-cultural acceptance of the product.
- To assess economic viability of the novel product and carry out Value for Money analysis along witha suitable packaging material and labeling so as to make the product marketable.
- To carry out Hazard Analysis and Critical Control Point (HACCP) and to manage CCP's of the developed novel product with the view of Total Quality Management.
- To offer knowledge and a potent solution to:

i. Waste management.
ii. Rising demand for healthy and nutritious diet with economic pricing.
iii. Phytomedicines, nutraceutical, food ingredients, functional foods.

IV. Materials And Methods

A. PROXIMATE PRINCIPLES:

This section of the research endeavor focused on identifying, characterizing and quantifying the various nutritional principles of Papaya peels and the vinegar obtained from the same.

i) Samples utilized

Locally procured semi-ripe papayas (Quantity-2) were utilized for analysis. Selection was based on various parameters namely ripening stage, size, absence of defects and color uniformity etc. Each papaya was separately subjected to proximate analysis and vinegar formation.

ii) Processing of samples

The papayas were washed with potable water to remove dirt followed by manual peeling of the fruit, subsequent to which a water wash was given to remove presence of any mucilage. Peels of each individual papaya were divided into two parts A, for proximate analysis and B, for vinegar formation. The steps involved in the processing are detailed as follows:

a) For Proximate Analysis

This involved the following distinct steps:

Drying of sample:Part A contents of both the papayas were separately spread over clean, dry trays and dried for 2 days under sunlight. The trays were then placed in KANDEE – Dehydrator KD-HS/10T set at 70°C for complete moisture removal. Once a constant weight was achieved, the contents were cooled and finely ground in a mixer-grinder. The powdered mixture was passed through a sieve to obtain uniformity. Further, the

procured powder was sealed in air tight containers, labeled as S1 and S2, and was used in the estimation of carbohydrates, proteins, vitamin C, and other nutrients.

Proximate Principles:

The following proximate principles were analyzed from the two samples of papaya peels:

1. Estimation of Carbohydrate content by Difference method.
2. Estimation of Protein content by Kjeldahl method.
3. Estimation of Fat content by Soxhlet method.
4. Estimation of Moisture content by Oven dry method.
5. Estimation of Ash content by Dry ashing
6. Estimation of Crude Fibre content Weende method.
7. Estimation of Calcium content by EDTA titration.
8. Estimation of Magnesium content by EDTA titration.
9. Estimation of Iron content by Ramsay's Method.
10. Estimation of Phosphorus content by Fiske-Subbarao's Method.
11. Estimation of Vitamin C content by Bessey and King Method.

b) Vinegar Formation

Part 2 contents of each papaya were chopped into smaller pieces and separately added to hot water sterilized glass jars consisting of a predetermined amount of sugar solution. Both the jars were covered with a cloth to avoid contamination, labeled as S1 and S2 and kept undisturbed in a clean dry dark place, away from direct sunlight, thereby subjecting to natural fermentation.

The peels were strained off as soon as bubble formation ceased. Once desired acidity was achieved, two variants were prepared viz V1 (honey) and V2 (herbal).

In addition, the following characterization studies of vinegar were carried out:

1. pH
2. Specific Gravity
3. Total Solids
4. Titrable Acidity

B. SENSORY EVALUATION:

Organoleptic evaluation applies the principles of experimental design and statistical analysis through human senses of sight, smell, taste, touch and hearing for the purpose of evaluating customer products. The subject requires panels of human analyzers by whom the products are tasted and their response recorded. Evaluation of any food product involves assessment of its nutritive and sensory quality by applying statistical techniques to the results. Basic characteristics of an individual are inheritability and sensitivity.

This is especially relevant as the human system's sensory output has 4 important characteristics:

- Each sense is governed by specific biochemical activities and is capable of individual action.
- There is a synergistic effect of one or more senses in which case the biochemical effect is more sophisticated.
- The response to the stimulus by the sense is mediated through nervous transmission and is based on previous neural input i.e. memory.
- Sensory evaluation has many applications where the input governs both positive and negative responses.

Sensory quality, as ascertained by the techniques of sensory evaluation, is a parameter of great importance to both the processor and the consumer. To the processor since it attracts consumers and the consumers since it satisfies the aesthetic and gustatory sense. Sensory quality is a combination of different sensors of perception coming onto play in choosing and rating a food; which are as follows:

- Appearance- which can be judged by the eye; for example parameters like color, size, shape, uniformity and absence of defects are of first importance in food selection.
- Kinesthetics, the next important attribute concerns texture and consistency.
- Flavor, which embraces the sense of taste, smell and feelings.
- After taste measurements, sensations perceived after food is swallowed or rinsed in the mouth.

i. Assessment of organoleptic characters of acetic acid:

Both the variants of papaya peel vinegar were evaluated by 9 expert panels [Descriptive Flavor Assessment Panel (DFAP)] who conceptualized and graded the product based on the attributes of appearance and bouquet. DFAP consists of individuals who are experts in sensory evaluation techniques and follow ASTM standards to assess and suggest constructive inputs to introduce innovations so as to make a unique and tangible venture in the process of novel product development. A score card of 9 point hedonic scale with 30 attributes related to aroma was provided with samples labeled as S1 (honey) and S2 (herbal) in GRAS grade glass containers for

evaluating the samples.The data obtained was evaluated biostatistically and deduction of preferred variant was ascertained through graphical principles.

ii. Assessment of organoleptic acceptability of sweet and spicy sauce:

For this study, a multipurpose sweet and spicy sauce was developed as the product for evaluation. This sauce aimed to be low-calorie, highly nutritive food, which elevates the natural flavor and biochemical benefits of vinegar thereby functioning as a healthier condiment. In order to project the organoleptic appeal and acceptability of the developed product, sensory evaluation was carried out with a semi-trained panel. A panel comprising of 20 panelists (biostatistically significant number of panelists) were chosen for evaluation. Panelists were to answer a detailed questionnaire based on both non-invasive and invasive parameters. Non-invasive parameters assessed the general awareness of the consumer w.r.t. the various nutritional qualities of vinegar, its incorporation into food and the acceptability of the idea of waste utilization in food products. In the invasive section of the questionnaire, panelists graded the sample based on various sensory attributes. It also focused on the marketability of the product, its value for money, consumer preferences for product consumption to elucidate the overall acceptability of sauce.The data obtained from the questionnaires was evaluated using bio-statistical principles to ascertain the acceptability of the product. Also, the marketability of the product developed was ascertained using the parameter of Value for Money or VFM.

C. ASSESSMENT OF CRITICAL CONTROL POINTS (CCPs) IN THE PRODUCTION OF SWEET AND SPICY SAUCE:

HACCP:

HACCP is a management system wherein food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product. An efficient HACCP system aims to prevent hazards in production processes that can cause the finished product to be unsafe, and designs measurements to reduce these risks to a safe level. In this manner, HACCP is referred as the prevention of hazards rather than finished product inspection.

Identification of Critical Control points:

A critical control point (CCP) is a point, step, or procedure in a food manufacturing process at which control can be applied and, as a result, a food safety hazard can be prevented, eliminated, or reduced to an acceptable level. In the case of novel product development, critical control points generally involve optimizing culinary parameters for preparation of the recipe. In addition, synergistic parameters like hygiene and sanitation measures which indirectly influence product quality are also considered. The identification of critical control points basically revolves around defining the critical limits for any ambiguity in the manufacturing process. A critical limit is the maximum or minimum value to which a physical, biological, or chemical hazard must be controlled at a critical control point to prevent, eliminate, or reduce to an acceptable level. Monitoring activities are necessary to ensure that the process is under control at each critical control point. This is regularly achieved by quality testing of ingredients and routine sensory evaluation at various stages of product manufacturing. One of the accessory requirements of a CCP system is the thorough understanding and implementation of corrective actions which ensures that the product obtained is not injurious to health or otherwise adulterated as a result of the deviation.

The CCPs for production of sweet and spicy sauce at various stages are elaborated as follows:

Phase I: Fermentation

1. *Raw Ingredients:*

- Look for firm, evenly coloured papayas having no additional odor.
- The sugar to be used must be of fine quality devoid of any foreign substances.
- Water used in the fermentation process must be potable and free from impurities.
- Honey used for flavoring needs to be of good quality, unadulterated, free of visual defects with right amount of viscosity.
- Herbs selected ought to be thoroughly dried with no traces of foreign matter. Fresh herbs to be used are bright, tender, uniform and devoid of all defects.

2. *Pre-fermentation process*:

- Papayas should be washed with potable water before manual peeling them.
- The peels must be thoroughly washed to remove mucilage and then excess water is to be strained out to minimize moisture content.
- Peels are to be cut evenly into small pieces of equal sizes for proper fermentation to occur
- The glass jars of GRAS grade must be sterilized with hot boiling potable water to minimize cross contamination.

- All the equipments used during chopping, cutting, handling, etc. should be clean.

3. *Fermentation process:*

- Once all contents are added to the glass jar, it should be covered with muslin cloth to circumvent possible contaminations such as dirt, dust, flies, etc.
- DO NOT LID THE JAR.
- The jars should be kept away from sunlight, in a dark place.
- Regular stirring is required to shun mold formation.
- Fermentation should be carried out for exactly 1 month.

4. *Post-fermentation process:*

- Obtained vinegar should be carefully strained out in sterilized bottles when reached to a pH of at least 2.5.
- Addition of flavorings is to be done using sterilized utensils.
- The vinegar must be properly stored until further use.

Phase II: Product Development

1. *Raw Materials:*

- Select firm, bright colored, fresh cayenne peppers and chilies.
- The sugar and corn flour to be used must be of fine quality devoid of any foreign substances.
- Garlic cloves to be used should be fresh, entire and not broken.

2. *Pre-cooking process:*

- Ingredients are to be given a thorough wash with potable water prior cutting.
- Cayenne peppers should be cut evenly into small pieces as well as in equal lengths.
- Chilies and garlic cloves are to be finely chopped.
- All the equipments used during chopping, cutting, handling, etc. should be clean.

Figure 1: Formulated Product

3. *Cooking process:*

- All ingredients should be put into a clean pan and heated.
- All ingredients to be used in the specified quantity.
- Potable water should be added and heated to get a desired consistency for the sauce.
- Moisture content should be bought to minimum to avoid growth of microbes.
- All the equipments used during the process should be clean.

4. *Harvesting of the product:*

- The sauce first should be air cooled.
- The sweet and spicy sauce should be filled in a clean sterilized air tight container (GRAS grade) with a headspace on top.
- Refrigerate until further use or keep away from direct sunlight under room temperature.

5. *Post-harvest Conditions:*

- Open the sweet and spicy sauce only when required and use a clean utensil (spoon) to stir and take out a desired quantity.
- Do not use the same spoon again
- Refrigerate until further use or keep away from direct sunlight under room temperature.
- Consume the product within specified period.

6. *Sensory evaluation*:

- The product should be presented in clean and dry container.
- Crackers to be given as accompaniment.

D. SHELF LIFE STUDIES:

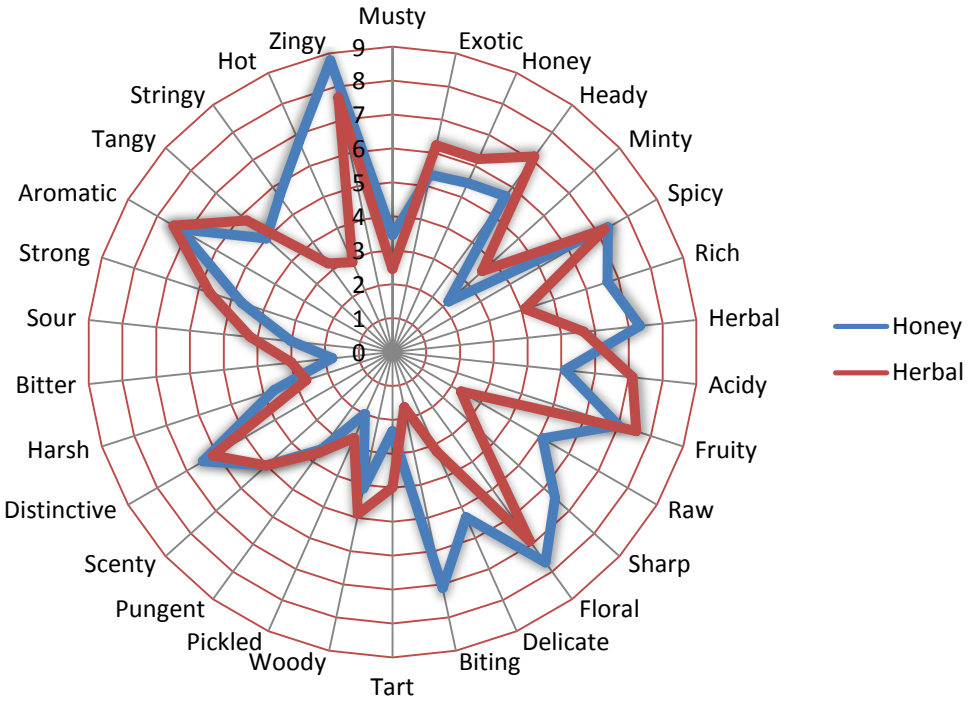
One of the most important considerations when developing a new food product or reformulating an existing one is to ensure that the food products desired properties, quality and safety are maintained throughout the product entire shelf life and stated storage conditions. Ingredients, foods and supplements can undergo deteriorative changes during their shelf life that can impact on their chemical, sensory and nutritional properties (texture, appearance, flavour, nutritional value and beneficial health effects). Shelf life studies provide a basic picture of the microbial activity of the product over a period of time as the ubiquitous nature of microbes affects keeping quality of any food product.

To check the microbial safety of the formulated product, laboratory tests were carried out as per AMA Standards. Periodic sampling of the product was done for a span of one month with an interval of 7 days. Testing was performed on selective culture media: Nutrient Agar, Sabouraud's Agar and MacConkey's Agar for the enumeration of general bacteria, yeast and molds and coliform bacteria.

V. Data Analysis: Sensory Evaluation

1. Papaya Peel Vinegar:

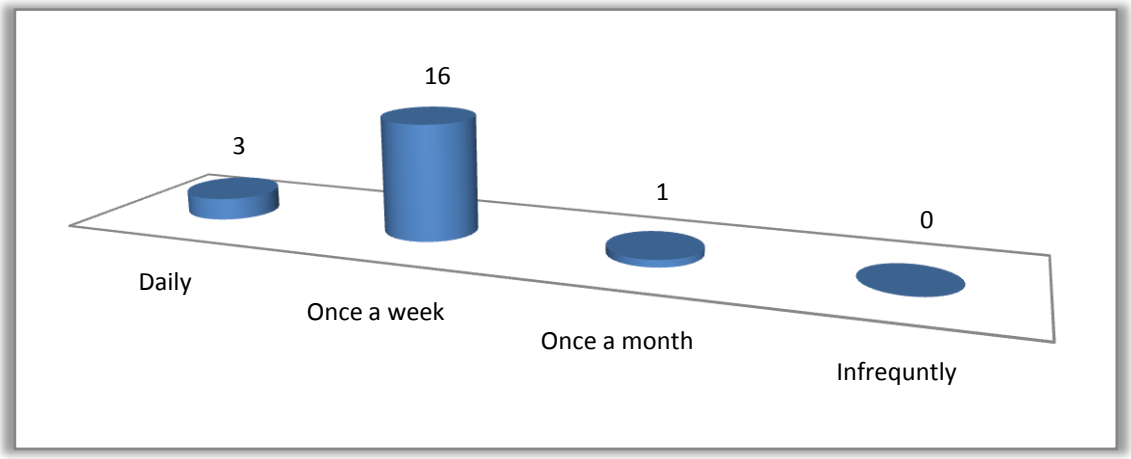
The multivariate data obtained from the panelists on their judgment of the two variants of vinegar was graphically tabulated as follows.



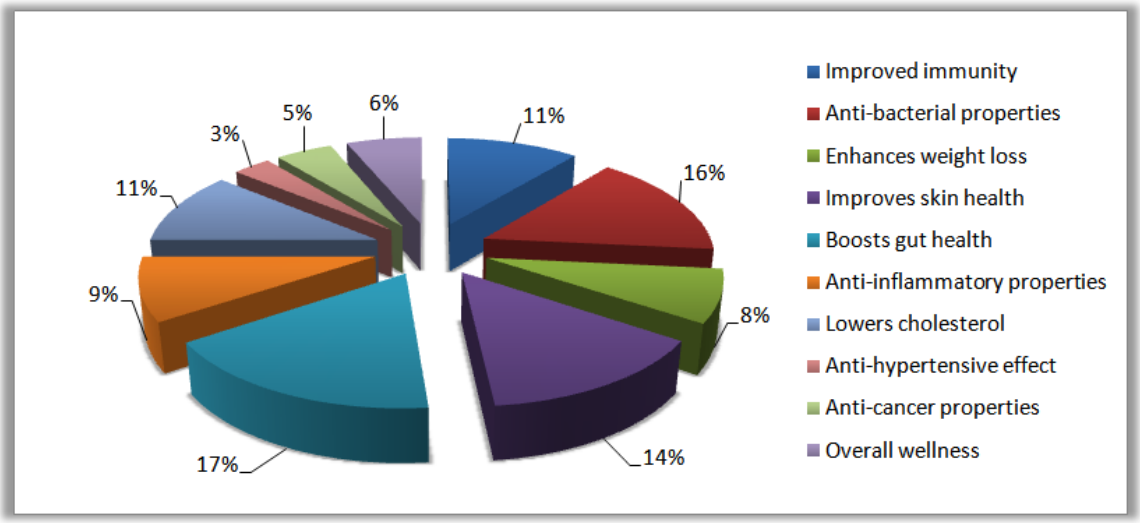
2. Sweet and Spicy Sauce:

i. Non-invasive

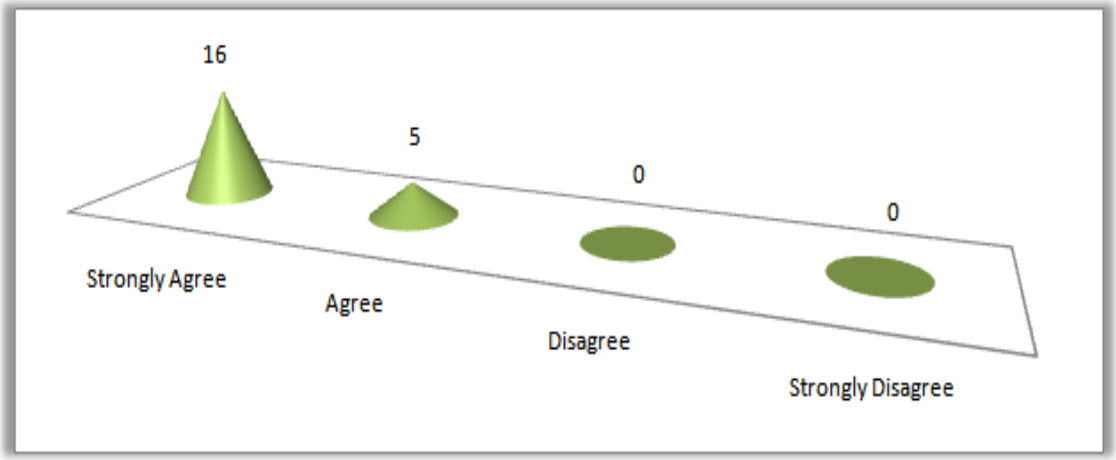
Panelist opinions on their frequency of consumption of sauces and/or dips:



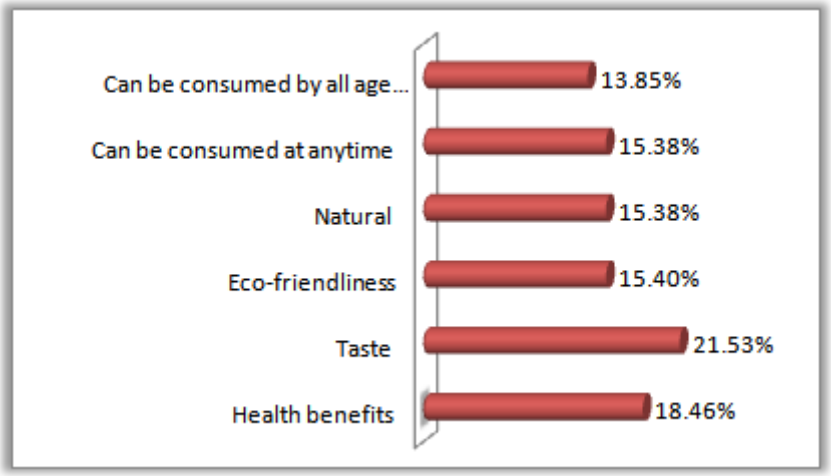
Panelists' awareness on the nutritional benefits of vinegar:



Panelist opinions on whether the idea of inedible papaya peels being transformed into vinegar to combat industrial pollution and then being used in novel product development:

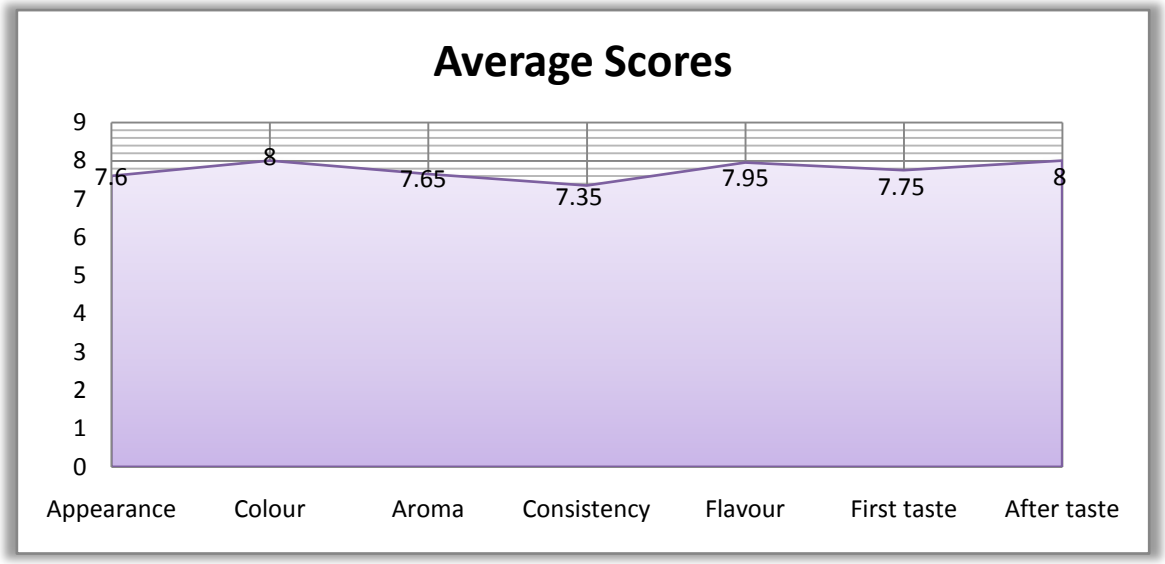


Panelist opinions on qualities of the modified product intrigue them:

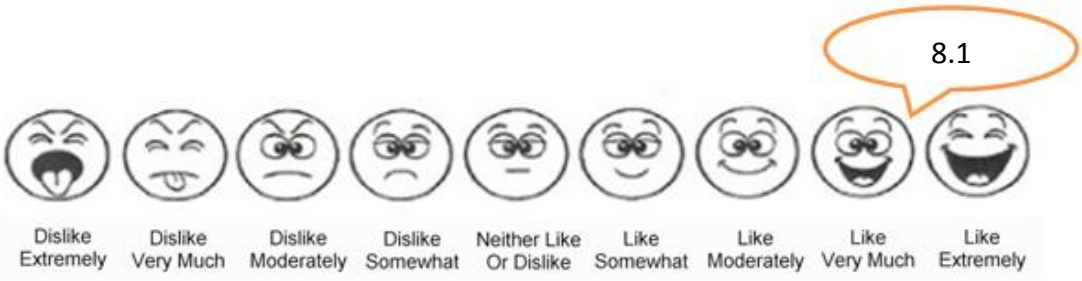


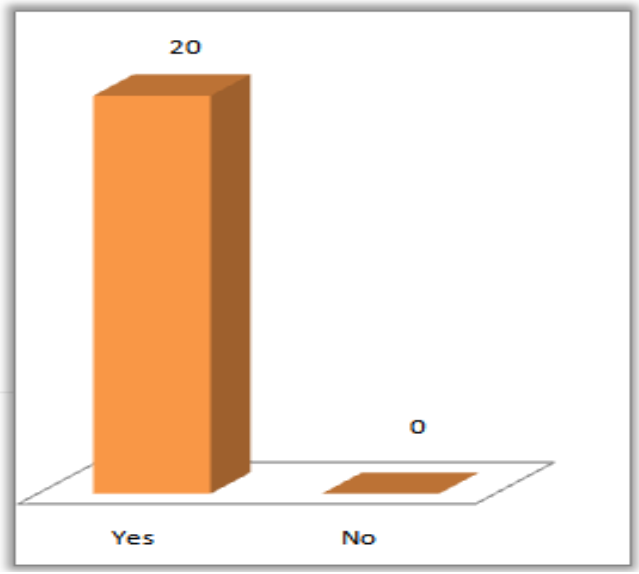
ii. Invasive:

Panelist assessment of the product in general:



Panelist opinion on overall acceptability:

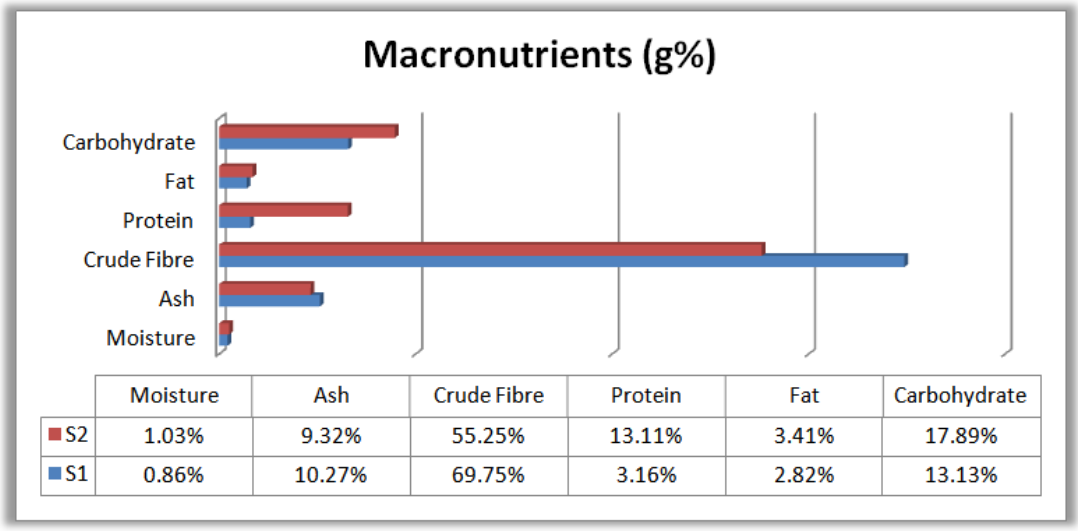




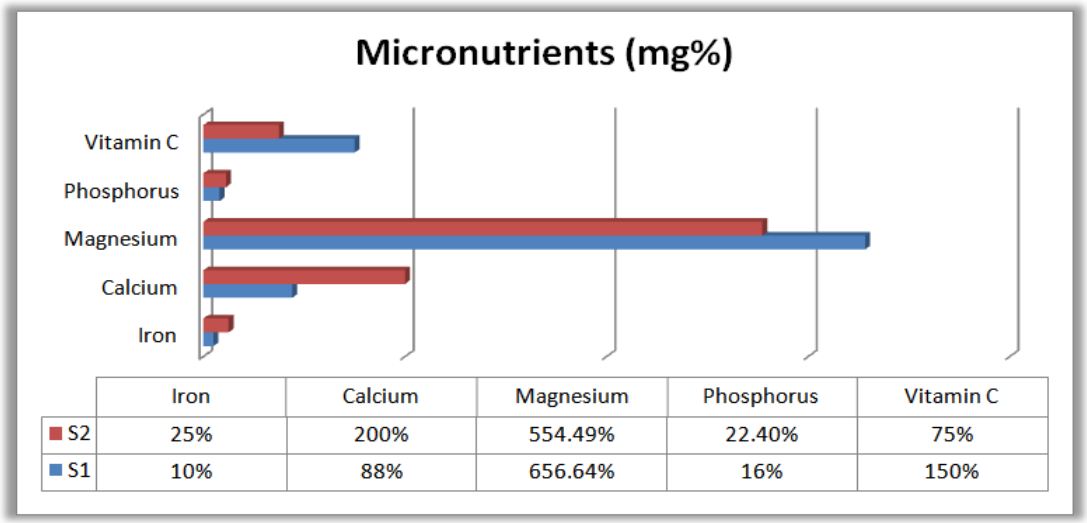
Panelist opinions on whether they will buy the sweet and spicy sauce if it were commercially available:

VI. Results And Discussions

A) ***PROXIMATE ANALYSIS****:*



	Moisture	Ash	Crude Fibre	Protein	Fat	Carbohydrate
S2	1.03%	9.32%	55.25%	13.11%	3.41%	17.89%
S1	0.86%	10.27%	69.75%	3.16%	2.82%	13.13%



	Iron	Calcium	Magnesium	Phosphorus	Vitamin C
S2	25%	200%	554.49%	22.40%	75%
S1	10%	88%	656.64%	16%	150%

B) ***CHARACTERIZATION STUDIES OF VINEGAR:***

Principles	Variant 1	Variant 2
pH	2.3	2.1
Specific Gravity	1.012	1.035
Total Soluble Solids	8.5%	10.2%
Total Acidity	1.12%	1.09%

Table 1: Results from Vinegar Analysis

C) SENSORY EVALUATION:

The data obtained from sensory analysis of the product can be elucidated as follows:

- All the respondents (100%) were found to have a general likeness towards sauces and dips; which of course is a known fact based on the fact that these are the most widely consumed add-ons with any meal.
- Flavor preference is solely based on respondent's affinity towards the selected flavor. That been said, many respondents selected more than one flavor option indicating variation in choice as per wish. The most well-known brands among the respondents (72%) were Kissan, Maggi and Smith & Jones.
- Majority of the respondents (80%) conveyed that they consumed sauces on a weekly basis along with the most favorite – savory snacks (40%) followed by chips (35%). On being asked about the kinds of sauces they preferred (packaged or homemade), the respondents (75%) were content with both.
- Taste (45%) and convenience (40%) are the top reasons for respondents in consuming sauces.
- All the respondents were found to be well versed with some, if not all, health benefits of vinegar with "boosts gut health" being the most selected option.
- 80% of the respondents strongly agreed to the idea of biotransformation of papaya peels to vinegar for production of a novel product with all the qualities of the proposed product.
- Talking about the product itself, the product was found to be highly appreciated gaining an overall average acceptability of 8.1 on a 9 point hedonic scale.
- 90% of the respondents chose the option "appropriately tasty" indicating no need for change in recipe
- Addressing the versatility factor, most respondents preferred to have the product as dip (70%) followed by as a sauce. Acceptability was high in terms of being consumed with crackers.
- Most elected packaging material was squeezable pouches (50%) with a price range suggested as Rs. 40- Rs. 150.
- All of the respondents (100%) ascertained that they were not only willing to buy the product but also professed to recommend it to others.

D) PRODUCT SPECIFICATION:

i. Product Information:

The sweet and spicy sauce is a versatile condiment which addsan oft-needed kick in regular meals. This ultimate customization tool adds a combination of more spice, sweetness, and hotness to the traditional Indian thali.Inspired by Western cuisine, the recipe has been tweaked as per Indian flavours thereby reflecting both our evolving tastes in IndoWestern food, as well as our love for the traditional classics.

To define the use of the product it was tested as a dip with unflavored crackers. The results were excellent. The sauce complimented the crackers offering a zesty taste. The product is proposed to be served as a dip or sauce or marinade to countless dishes at barbeques, lunches and light meals.

The product proves to be a healthier alternative against existing condiments, made from bio valorized fruit waste that may encourage consumers who are health concious as well as who believe in sustainable development.

ii. Ingredient Declaration:

Below the ingredient declaration is denoted in terms of statutory requirements:

Ingredients: Water, Granulated sugar, Fruit Vinegar, Cayenne pepper, Green chilies, Garlic, Soy sauce, Corn starch.

iii. Shelf Life:

After assessing the shelf life of the formulated product by regular testing for a period of over a month with an interval of 7 days abreast maintaining proper storage conditions,it was perceived that the microbial quality of the product started to decline at a faster rate after week 3. The shelf life was thus determined to be approximately 3 weeks under proper storage conditions. It can be enhanced by addition of natural or nature like additives.

iv. Nutritional Information:

Table 2 below details the nutritional information of the Nutritionally Enhanced Multipurpose Sweet and Spicy Sauce, which was assessed with the use of standardized AOAC protocols.

Nutrients	Values per 100 g
Energy	232.301 Kcal
Carbohydrates	25.978%
Protein	2.593%
Fat	13.113%
Moisture	54.054%
Ash	0.162%
Crude Fibre	4.1%
Calcium	48.096 mg
Magnesium	58.368 mg
Iron	140 mg
Phosphorus	8 mg
Vitamin C	37.5 mg

Table 2: Nutrient Content of the Product

v. Packaging:

Packaging enhances the life span of many perishable food items. The package for the formulated product should offer sufficient barrier against light, moisture, gases, and other environmental factors. Apart from this, it should also protect the organoleptic characteristics (quality attributes) of sauces viz. colour, flavour, taste and overall acceptability. The package should prevent emission of off-flavours. The package must be "chemically clean and inert", and it should be able to perform at high processing speeds. In order to protect leaching out of powerful flavor ingredients through film structures thereby causing de-lamination, chemical resistant adhesives and primers can be used to assure packaging integrity.Proposed packaging materials for the product are listed as follows:

- Heat Set Glass Bottles in Biodegradable Cardboard Casing
- Flexible Sachets
- PP/EVOH/PP Bottles
- Stand-up Pouches

vi. Label Information:

The following information ought to be included on the label:

- Price: Rs. 30/550 ml {As per VFM Analysis}
- Allergen: Contains vinegar, soy
- Storage Conditions: Refrigerated conditions. Consume within 3 weeks of opening.

(Vegetarian symbol, Manufacturing date, Nutritional information, Ingredients, Health claims, Name of the product, Name of the manufacturer etc.)

VII. Conclusion

Papaya is one of those few ingredients, which possesses the dual benefits of balanced nutrition and highly acceptable organoleptic profile. Famous for its luscious taste and sunlit colour of the tropics, ripe papaya is a repertoire of nutrients, promoting health status.Though the pulp is mostly favored for consumption, there are a lot of hidden nutrients in the seeds and the peel that are yet to be discovered.The proximate analysis showcases a balanced nutritional profile, thus exhibiting great potential to be marketed in the form of innovative products in the food industry.Organoleptic analysis involving the semi-trained panelists exhibited high acceptability for the product developed from bio valorized papaya peel. Also, the product developed ascertained high VFM.In addition, mass manufacturing of the developed product is feasible with the ideal identification of Critical control points.

Lastly, the elucidated idea of waste utilization is of practicality and viability, paving way to explore the untapped potential of industrial wastes and marketing these cheap value added sources as nutraceuticals to enhance human wellness.

Acknowledgements

We, Shafaque Khorajia and Akshata Nayak, students of College of Home Science-Nirmala Niketan, Mumbai,while presenting this research paper acknowledge with gratitude our Principal Dr. Geeta Ibrahim for providing the necessary infrastructure and resources to accomplish our research work. We express our sincere and deepest indebtedness to our guide cum friend, Dr. Jyoti D. Vora whose expertise, invaluable guidance, constant encouragement, affectionate attitude, understanding, patience and healthy criticism added considerably to our experience. Words fall short to describe her and her continual inspiration, without which it would have not been possible to complete this study.We are highly thankful to Mr. Sunil Sir and Mr. Vinayak Sir for always helping and supporting with the laboratory aids.We gratefully acknowledge the assistance we received in all forms from all the students, teaching and non-teaching staff of both colleges, Ruia as well as Nirmala Niketan.

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