

Evaluating an *Oryza sativa* L. Based Fermented Beverage 'Pendām': A Source of Sustainable Diet to Gadāba Ethnic Community of India

ABSTRACT

Focussing on the need of sustainable diet, this research aimed to understand the nutritional feature of a traditional fermented beverage named as 'Pendām'. As it is widely consumed in study region, participant observation method applied to understand the complete preparation process. In order to understand the quality of *Pendām*, the nutritional compositions were analysed using standard methods. With pH value of 3.6, this beverage reflects a protein and carbohydrate content of 1.614 mg/ml and 3.01 mg/ml respectively. Fat and yeast are absent in the beverage. The energy value stands at 1.8496 Cal/100 ml. Having cultural importance within the community, *Pendām* is considered sacred and play strong role in rituals and festivals. The nutritional features ensure it as a sustainable beverage.

Keywords: Gadāba; fermented beverage; *Oryza sativa* L; *Pendām*; sustainable diet.

1. INTRODUCTION

Indigenous fermented beverage is an integral part of the ethnic culture. Such beverage practices are geographically confined and particularly connected to social process and ethnic norms [1]. Thus the diversity of food and beverages is based on the availability of raw material. The knowledge on indigenous food products or beverages acquired and processed in the context of ecological background in which ideas and expertise are situated, well-conserved and carried forward by generations. Food or beverages have unique importance among populations due to their distinctive sense of acceptability, ethnic inheritance, health benefits, religious and cultural standards [2]. World Health Organisation underlined the socio-cultural and economic significance of such beverages and considered these as unrecorded alcohol [3]. Appropriate application of traditional knowledge would support food safety, better health and proper resource management [4,5].

Fermentation of beverages from cereals were common among the early civilizations of Middle east, Indus valley, Egyptians, Greeks and Romans [6]. Rice as an important crop of world showcased various forms of fermented beverages since long time. As a traditional crop to make food and beverages, it involves starter culture for fermentation procedures to enhance microbial properties [7]. The fermentation

process of rice showcased formation of lactic acid bacteria and bacillus responsible for improvement in digestive system and immune response [8]. Fermentation is also responsible for enhancement of flavour, amino acids, minerals and vitamin content [9]. The fermented beverage from rice is found in several parts of India like *Xaj Pani* in Assam, *Apong* in Arunachal Pradesh and *Handia* in north Odisha. Such fermented products are made naturally or by development of starter culture. These starters are responsible for changes in biochemical configuration and sensory properties of products [10]. With nutritional benefits, these beverages benefit a large group of population belonging to low income groups. Such beverages are assumed to have affirmative health impacts like gastrointestinal cure, anti-ageing properties, lowering cholesterol and stimulating the immune system [11].

Taking into account the Census report 2011, the population of *Gadabas* in Odisha is 84,689 whereas Koraput administrative unit accounts for 80.23% of *Gadaba* population of the state. This ethnic community is enriched with folk traditions, rituals and festivals. The name Koraput seems to be a denuded form of the term '*Khora*' apparently a surname of *Gadabas*. *Gadabas* are the earliest cultivator of this region and developed various indigenous food and beverages for consumption [12]. The dietary structure exhibits their ethnic awareness of agriculture and relationship with

forest setting. *Pendam* is generally rice based fermented beverage considered sacred and mandatorily consumed during festivals and marriage functions. It has cultural significances to the life of *Gadaba* community. *Gadabas* offer *Pendam* to deity on several rituals and festivals [12]. It is given as an obligatory drink to guest on arrival during various occasions of religious importance. *Pendam* is compulsory on many life events of *Gadabas* including birth, funeral, festivals, crop harvesting and social meetings. Hence it remained as a favourite libation among the *Gadabas*. In this study, the preparation process in Komarguda village under Lamtaput block of Koraput district was learnt through participant observation. An attempt has been made to understand the complete procedure of preparation of the ethnic '*Pendam*' along with its nutritional analysis.

2. MATERIALS AND METHODS

The thorough preparation procedure of *Pendam* observed with the help of brewer. The laboratory analysis conducted at the 'Biochemistry and Molecular Biology Laboratory', Ravenshaw University for nutritive features comprised of pH, fat, protein, carbohydrate, energy, forms of amino acids, yeasts and bacteria. A standard pH metre and pH paper used to record the pH of beverages. Spectrophotometer used to estimate the absorbance for protein and carbohydrate.

Estimation of Protein:

The occurrence of protein identified through Lowry method with Folin phenol reagent [13].

Reagents:

- Solution A – Alkaline sodium carbonate 2% (w/v) in sodium hydroxide (0.1N).
- Solution B – Copper sulphate (CuSO₄) 0.5% (w/v) in distilled water.
- Solution C – Potassium sodium tartrate 1% (w/v) in distilled water.
- Biuret reactant – Mixture of A, B & C in ratio 100: 2: 2 and formed before acid.
- Folin solution – Mixture of sodium tungstate & sodium molybdate in H₃PO₄ and HCL.
- Folin-ciocalteu – It is diluted in H₂O (1:2) V/V and produced earlier to acid.
- Normal protein – Bovine Serum Albumin (BSA) in H₂O.

Process:

(a) 0.1, 0.2, 0.3, 0.4 and 0.5 ml of usual protein drawn in sample tubes in duplicates with BSA vary from 20 to 100 ug. (b) Each sample tube was levelled to 0.5 ml with H₂O. (c) A blank specimen formulated as 0.5 ml of H₂O with no protein. (d) 5 ml of Biuret reactant supplemented to all samples. (e) A cyclometer used to stir all samples. (f) All samples were left for incubation (ten minute). (g) Folin solution induced in each sample tubes. (h) Then the samples incubated for half an hour. (i) Spectrophotometer remains on to stabilise for half an hour. (j) Absorbance of samples recorded at 700 nm. (k) A graph drawn with protein on X and absorbance on Y-axis.

Determining Carbohydrate by Anthrone Method:

Carbohydrate measured by using Dreywood's Anthrone reagent [14]. Initially carbohydrate hydrolysed to simple sugar using H₂SO₄ in hot acidic standard. Glucose is dehydrated in hydroxymethyl furfural.

Reagents:

- Glucose standard mixture: 10mg of glucose in 100ml of H₂O.
- Anthrone reactant: 0.2g anthrone in 100 ml of concentrated H₂SO₄.

Procedure:

(a) Glucose mixture of 0.1 mg/ml applied in sample tubes induplicate with a range between 20 to 100 ug. (b) H₂O applied to every sample tube followed by 4 ml of anthrone reactant. The final value in sample tubes remain 5 ml. (c) Cyclometer used to stir all samples and incubation done for 10 minutes with 970 degree Celsius. (d) Post-incubation, the absorbance of samples recorded at 620 nm. (e) A graph drawn with glucose on X and absorbance on Y-axis.

Gram's staining to identify bacteria:

Process:

One droplet of H₂O applied on glass slide. After sterilization of a wire loop, a bacterial colony was picked and added with the droplet on slide to form a smear. Chemicals are put on the smear. Crystal violet put on for 1 minute and then mordant for 1 minute. It was finally washed by H₂O. Decolourizer was put on for half second and cleaned with H₂O. Then Safranin used to put on for 1 minute and cleaned from the smear. Post slide withering, observation done under microscope.

3. RESULTS AND DISCUSSION

The preparation of *Pendam* initiated with the preparation of starter tablets. The starter tablet is responsible for fermentation process.

3.1 Preparation of Starter Tablets

The starter for *Pendam* is made with rice-based tablets, locally named as *baddi* (Fig. 1). These

tablets are made up of mixture of some plant products (Table. 1) with a small portion of rice.

Initially the boiled rice is semi-dried and in next phase mixed with the plant products to finally (hand moulded) prepared in the form of round shaped tablets. The plant products are of immense medicinal importance. *Plumbago Zeylanica* is helpful to cure dysentery, diarrhoea and liver issues. '*Plumbagin*' is the active ingredient present in the root of *plumbago zeylanica* which is soluble in ethanol and

Table 1. Parts of the plant used in preparation of starter tablets (*Baddi*)

Local Name	Botanical Name	Family	Parts Used	Medicinal importance
<i>Chhitramauli</i>	<i>Plumbago zeylanica</i> L	<i>Plumbaginaceae</i>	Root	Anti-dysenteric and anti-diarrhoea
<i>Shukli Mundi</i>	<i>Heteropogon contortus</i> L	<i>Poaceae</i>	Root	Reduce irritability
<i>Jada (castor)</i>	<i>Ricinus communis</i> L	<i>Euphorbiaceae</i>	Leaf	Reduce inflammation and pain
<i>Kudei cher</i>	<i>Holarrhena pubescens</i> Wall. Ex G. Don	<i>Apocynaceae</i>	Stem bark	Anti-diarrhoea

consider with high anti-oxidant capacity of ethanol extracts [15]. *Heteropogon contortus* has diuretic and stimulant properties which are added as a component of medicine against irritability. Due to the presence of alkaloid '*Ricinine*', castor leaves can reduce stomach inflammation and pain. Presence of alkaloid '*Conessine*' in the stem bark of *Holarrhena pubescens* act as an anti-dysenteric agent. The stem bark is used to cure diarrhoea with fever and liver disorder [16]. These tablets are sold in weekly or daily markets by certain section of people.

3.2 Preparation Process of *Pendam*

Pendam is a customary drink on every occasion of the *Gadabas*. It is generally rice (*Keram*) i.e. *Oryza sativa* L. based beverage mixed with various plant products. In few cases *pendam* is prepared with a mixture of grains like rice i.e. *Oryza sativa* L., foxtail millet (*Kangu*) i.e. *Setaria italica* L. and little millet (*Iri*) i.e. *Panicum sumatrense* L.

Initially, these are cooked and dried over castor leaves for long hour. Then it is pounded slightly with a traditional tool called as *rumna* (Fig. 2) for fine texture. After the mixing of tablets with the existing pounded rice, it is kept in a vessel made of mud with castor leaves as a base. A small amount of water is poured and the mud vessel is covered through a handmade basket for four to five days to get better fermentation. In some areas before fermentation bamboo leaf is added with the solution to neutralise the strong smell.

Finally, the prepared solution (Fig. 3) is mixed with sufficient water and strained with washed fabric for final consumption. The *pendam* (Fig. 4) is regarded as sacred among the *Gadaba* population and served in each festival as well as in marriage programmes. It is given as a form of gift to relatives in the time of arrival or departure.

3.3 Nutritional Analysis of *Pendam*

The nutritional profile of beverage reflects its suitability as a sustainable choice (Table 2). The pH has an important role due to the degree of acidity concerning beverage. The pH for proposed sample remained at 3.6. The protein value of sample is satisfactory for the beverage with 1.614 mg/ml. The fat content is absent in *Pendam*.

Qualitative tests for carbohydrate include: (a) Molisch- Positive (b) Fehling-Positive (c) Benedict-Positive (d) Barfoed- Positive. The carbohydrate content of *Pendam* found to be 3.01 mg/ml with the form of reducing sugar (*Hexose*). The energy value remained at 1.8496 Calorie/100 ml. Yeast is absent in *Pendam* while *Bacillus* sp. is the functional bacterium responsible for fermentation process of the *Pendam* (Fig. 5).

Amino acids are considered to be protein synthesizers. Following are the qualitative test conducted for amino acids: (a) Ninhydrin-Positive with purple colour, (b) Millon- Positive with Reddish brown, (c) Xanthoproteic- Positive.

Initially yellow colour but changed orange, (d) Sakaguchi- Positive with red colour, (e) Sulphide-Negative result. Amino acids found in *Pendam* provide a better picture for concerned beverage. *Tyrosine* and *Phenylalanine* are precursor to each other. *Tyrosine* is an aromatic amino acid may help in treat depression, anxiety, lower body fat and plays an important role in production of

thyroxin [17]. Though *Phenylalanine* is not recommended for people with phenylketonuria due to neurological disorders, it can be productive as a pain reliever in many cases [18]. *Tryptophan* is considered as an anti-depressant as well as a human metabolite. It helps in mitigating several diseases like diabetes and

Table 2. Nutritional profile of *Pendam*

Nutritional value	<i>Pendam</i>
pH	3.6
Protein	1.614 mg/ml
Fat	Absent
Carbohydrate	3.01 mg/ml
Form of carbohydrate	Reducing sugar (Hexose)
Energy value	1.8496cal/100ml
Forms of amino acid	Tyrosine (Y), Phenylalanine (F), Tryptophan (W), Arginine (R)
Yeast	Absent
Bacteria	Bacillus sp.



(1)



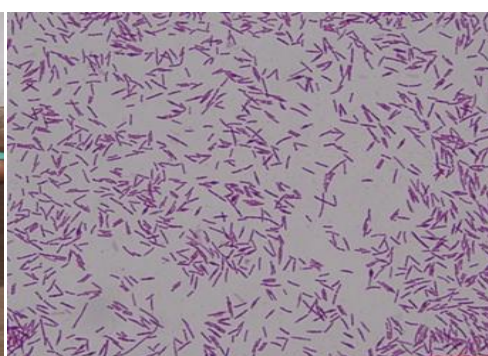
(2)



(3)



(4)



(5)

Fig. (1). *Baddi* (2) *Rumna* (3) Prepared beverage ready for filtering (4) *Pendam* (5) Gram's staining photograph of *Pendam*

kidney issues. *Arginine* is supportive to combat fatigue, stimulate the immune system and for treating heart diseases [19].

4. CONCLUSION

Pendam as an integral part of the cultural life of *Gadaba* community remained as a crucial portion of the ethnic identity. It is a customary beverage mandatorily used during several ritual and festivals. Use of various plant products of medicinal importance reflects the indigenous

knowledge of *Gadaba* community. The nutritional feature and therapeutic knowledge concerning *pendam* makes it a promising beverage of this region. Though it is prepared through traditional domestic procedure, a comprehensive scientific orientation can bring better processed results.

ACKNOWLEDGEMENT

We are thankful to the informants and particularly thankful to our primary informant Mr Dhanu Mudali and Mr. Gobinda Kirsani. We would like to thank Prof. Luna Samanta, Ravenshaw University for laboratory support.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Mishra AK, Bajpai R, Swain A. Finger millet-based staple beverages consumed by the Gadaba ethnic community of Odisha, India: Preparation and nutritive characteristics. *Biodiversitas*. 2021;22(5): 2737–2742. Available: <https://doi.org/10.13057/biodiv/d220535>
- Bultosa G, Molapisi M, Tselaesele N, Kobue-Lekalake R, Haki GD, Makhabu S, et al. Plant-based traditional foods and beverages of Ramotswa Village, Botswana. *Journal of Ethnic Foods*. 2020; 7(1):1–15. Available: <https://doi.org/10.1186/s42779-019-0041-3>
- Egea T, Signorini MA, Ongaro L, Rivera D, Obón de Castro C, Bruschi P. Traditional alcoholic beverages and their value in the local culture of the Alta Valle del Reno, a mountain borderland between Tuscany and Emilia-Romagna (Italy). *Journal of Ethnobiology and Ethnomedicine*. 2016; 12(1). Available: <https://doi.org/10.1186/s13002-016-0099-6>
- Dominics DA, Fuchaka W. Role of indigenous knowledge systems in the conservation of the bio-physical environment among the Teso community in Busia County-Kenya. *African Journal of Environmental Science and Technology*. 2016;10(12):467–475. Available: <https://doi.org/10.5897/ajest2016.2182>
- Tadesse, N. S., Beyene, G. F., Hordofa, T. B., & Hailu, A. A. (2020). Traditional foods and beverages in Eastern Tigray of Ethiopia. *Journal of Ethnic Foods*, 7(16), 1–13. Available: <https://doi.org/10.1186/s42779-020-00050-8>
- Ray M, Ghosh K, Singh S, Chandra Mondal K. Folk to functional: An explorative overview of rice-based fermented foods and beverages in India. *Journal of Ethnic Foods*. 2016;3(1):5–18. <https://doi.org/10.1016/j.jef.2016.02.002>
- Pakuwal E, Manandhar P. Production of Rice Based Alcoholic Beverages and their Quality Evaluation. *Journal of Food Science and Technology Nepal*. 2020; 12(12):37–48. Available: <https://doi.org/10.3126/jfstn.v12i12.30133>
- Puerari C, Magalhães-Guedes KT, Schwan RF. Physicochemical and microbiological characterization of chicha, a rice-based fermented beverage produced by Umutina Brazilian Amerindians. *Food Microbiology*. 2015; 46:210–217. Available: <https://doi.org/10.1016/j.fm.2014.08.009>
- Khan M, Singh K, Pandey S. Quality Aspects of Rice based Fermented Beverage. *Biomedical Journal of Scientific & Technical Research*. 2021;34(5):27096–27104. Available: <https://doi.org/10.26717/bjstr.2021.34.005609>
- Latha DP, Reddy SM, Youn KS, Ravindra P. Starter culture technology: Fermented foods. In *Advances in Bioprocess Technology*. Springer International Publishing. 2015;435–454. Available: https://doi.org/10.1007/978-3-319-17915-5_21
- Nath N, Ghosh S, Rahaman L, Kaipeng DL, Sharma BK. An overview of traditional rice beer of north-east india: Ethnic preparation, challenges and prospects. *Indian Journal of Traditional Knowledge*. 2019;18(4):744–757.
- Padhi SR. An Ethnographic Manifestation of Religious Life of Gadaba Tribe in Its Changing Dimensions. *Journal of Religion and Health*; 2020. Available: <https://doi.org/10.1007/s10943-020-01028-1>
- Lowry OH, Rosebrough NJ, Farr AL, Randall RJ. Protein measurement with the Folin phenol reagent. *The Journal of*

- Biological Chemistry. 1951;193(1):265–275.
Available:[https://doi.org/10.1016/s0021-9258\(19\)52451-6](https://doi.org/10.1016/s0021-9258(19)52451-6)
14. Morris DL. Quantitative determination of carbohydrates with Dreywood's anthrone reagent. *Science*. 1948;107(2775):254–255.
Available:<https://doi.org/10.1126/science.107.2775.254>
 15. Tilak JC, Adhikari S, Devasagayam PAT. Antioxidant properties of *Plumbago zeylanica*, an Indian medicinal plant and its active ingredient, plumbagin. *Redox Report Communications in Free Radical Research*. 2013;9(4):219–227.
Available:<https://doi.org/10.1179/135100004225005976>
 16. Zahara K, Panda SK, Swain SS, Luyten W. Metabolic diversity and therapeutic potential of *holarrhena pubescens*: An important ethnomedicinal plant. *Biomolecules*. 2020;10(9):1–28.
Available:<https://doi.org/10.3390/biom10091341>
 17. Jongkees BJ, Hommel B, Kühn S, Colzato LS. Effect of tyrosine supplementation on clinical and healthy populations under stress or cognitive demands-A review. *Journal of Psychiatric Research*. 2015;70:50–57.
Available:<https://doi.org/10.1016/j.jpsychires.2015.08.014>
 18. Ueda K, Sanbongi C, Yamaguchi M, Ikegami S, Hamaoka T, Fujita S. The effects of phenylalanine on exercise-induced fat oxidation: A preliminary, double-blind, placebo-controlled, crossover trial. *Journal of the International Society of Sports Nutrition*. 2017;14(1):1–8.
Available:<https://doi.org/10.1186/s12970-017-0191-x>
 19. Bahadoran Z, Mirmiran P, Tahmasebinejad Z, Azizi F. Dietary L-arginine intake and the incidence of coronary heart disease: Tehran lipid and glucose study. *Nutrition and Metabolism*. 2016;13(23):1–9.
Available:<https://doi.org/10.1186/s12986-016-0084-z>

© 2022 Mishra et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.