REVIEW ARTICLE

An Overview on Characterization and Value Addition of Traditional Indian Fermented Food: Idli

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ABSTRACT

Idli is a class of cereal/legume-based fermented food with spongy and soft texture with popularity and widely consumed in India. It falls under prebiotic and balance nutrition category. Since idli batter fermentation is a time-consuming stage, demand for ready to use idli batter has increased these days. The microorganism present on the surface of cereals and legumes which contributed in fermentation process to produce idli batter has been reviewed. Nowadays, starch, daidzein, and trypsin inhibitor activity were used as an indicator to judge the quality of idli, in which rice: black gram ratio is identified. A research area needs to be focussed on the packaging of idli batter or product idli to enhance the shelf life with maintain the physical as well as nutritional quality. The essential oil such as mustard oil and curry leaves enhances the shelf life of idli with proper refrigeration conditions. Combination of thermal treatment and electron beam irradiation is a promising method to extend the shelf life of idli. These reviews focus on the role of the ingredients used in the production of idli, identification of microorganism during fermentation of idli, nutritional and health benefits of idli, qualitative parameter for the analysis of biogenic amines, and shelf life extension of idli.

Key words: Adulteration indicators, biogenic amines, fermented food, idli

IDLI: A TRADITIONAL INDIAN BREAKFAST

Idli is an age-old traditional cereal/legume-based fermented steamed product having a spongy and soft texture which is liked by people and widely consumed food item in India. Idli has a vital contribution to the diet of the people as it is a source of vitamins, especially B-complex vitamins, protein, and calories due to the fermentation process. Idli is also known as "Rice cake." The popularity of idli within and apart from India has increased due to its attractive appearance, a flavor, appetizing taste, and spongy texture and gain as most favorite breakfast food snack.[1] There is an improvement in the nutritional qualities with decreasing anti-nutritional component along with increase in vitamin content in comparison with unfermented batter of idli.[2]

To satisfy the growing demand, there are various studies being carried out for the mechanization of idli production process.[3] Initially, Reddy *et al*. (1982) reported the formulation and process for the development of idli. There are various literatures available on idli like consumption pattern[4,5] and consumer perception of instant idli mix.[6]

Fermentation could be stated as one of the old methods that are used for food preparation that is discovered eras ago. It has been known and practiced by humankind long before the underlying scientific principles were understood. With the expanding world population and increasing poverty and hunger more and more people may be compelled to depend on plant foods, many of which are fermented products that tend to be easily affordable and available.[7] Fermentation process in food contributes as preservation techniques with the help of microbes, and well-known technique for a lot of years in India and across the globe, a varied range of fermented foods and beverages has a significant contribution to the diets of people in the world by improving nutritive value and organoleptic attributes to the food with addition of flavors.[8] Durgadevi and Shetty (2014) also reported the hydrolysis of

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protein during the fermentation process by naturally present microorganisms.[2]

MICROORGANISMS INVOLVED IN FERMENTATION OF IDLI BATTER

The fermentation processes in idli contributed from the microorganism (mostly lactic acid bacteria) which is present on the surface of rice and black gram and might be from utensils which responsible for acidification and leavening in batter.[9] The various microorganisms involved in the fermentation of idli. The production of acid in idli batter contributed by bacteria such as *Lactobacillus delbrueckii*, *Leuconostoc mesenteroides*, *Lactococcus lactis*, *Lactobacillus fermentum*, *Lactobacillus brevis*, *Pediococcus cerevisiae*, and *Streptococcus faecalis* and further yeast such as *Torulopsis holmii*, *Torulopsis candida*, *Trichosporon pullulans*, *Geotrichum candidum*, *Candida fragilola*, *Candida tropicalis*, *Candida kefyr*, *Rhodotorula graminis,* and *Hansenula anomala,* which shows pH reduction and that also shows riboflavin and thiamine content.[10-17] The lactic acid (≥1.0%) and carbon dioxide produce due to the metabolic activity of microorganisms which reduce the pH of the batter and make environment for working of microorganism, also create an anaerobic environment in the batter.[18] Sridevi *et al*. (2010) utilized lactic starter cultures such as *Enterococcus faecium* MTCC 5153 (Ef), *E. faecium* (IB2 Ef-IB2), and *Pediococcus pentosaceus* in combination with yeast culture *Candida versatilis* (CV) to understand the fermentation batter and sensory quality.[9] The author suggested that fermentation carried with the combination of culture is comparatively effective as natural fermentation of idli batter.

ROLE OF INGREDIENTS USED IN IDLI

The carbohydrate-rich foods like cereals contributed to the Asian Indian diet as a typical source of energy.[19,20] The most popular fermented product like idli made from rice and black gram which having soft spongy texture widely disbursed in the Indian subcontinent.[18] These are the best combination of cereals and legumes which could offer balance of carbohydrate and proteins in the diet.[3] Apart from the basic nutrients, after fermentation of cereal-legume based product delivers probiotics, prebiotics which carry fermentable sugar, and hydrolytic enzymes, etc. are health promoting.[21]

Rice

The widely consumed staple food of South India is rice.[22] After the wheat, it is the second cereal of the world, where two-thirds of the world's population widely consumed and fits in the description of health food items, where India is home for the production of various varieties. Ravi Kumar and Thomas (2018) reported that the rice consumed as cooked rice, is eminent way of eating rice through the process of three steps such as soaking, steaming, and drying of rough rice.[23] Rice is well known for as excellent source of carbohydrates, proteins, minerals, and vitamins. It is also familiar for low fat, low salt, and no cholesterol.[24]

Black gram

The black gram is a major ingredient of idli preparation and cultivated in India from ancient time, also expensive legume of country.[25] The mucilaginous properties of black gram made it as a key ingredient in idli preparation. The storage proteins such as albumins, globulins, and glutelins are present in black gram reported by Vanithasri and Kanchana (2013).[1] Ramakrishnan and Antony (2016) reported that nutrient presents in the black grams effect on the growth of the microorganism during the fermentation.[26]

Other cereals

Amaranth and finger millets are used to replace rice partially which results in an increase in the levels of microbial counts, various enzyme activities such as protease, phytase and amylase, soluble proteins, reducing sugars, titratable acidity, and antioxidant activity during fermentation.[27] Chelliah *et al*. (2017) used 10% of finger millet and pearl millet for idli preparation to enrich idli with minerals such as calcium and iron and reduced the fermentation time by 5–6 h.[28] Barnyard millet which recognized by other names is as shamula (M), sama (G), sawank (T), kuthiraivali (T), and shama (H), which the hardest category of millet, is used in the preparation of idli in the range of 30–50% in combination with rice which contains ample amount of protein and dietary fibers (soluble as well as insoluble).[1]

Idli preparation

The three parts of rice and one part of black gram are optimum ratio which used for the preparation of batter by soaking individually for 4 h which is time consuming traditional process. Further grinding to achieve fine paste with uniform mixing followed to 12 h of fermentation. Then, fermented batter place into molds in the form of cake and allowed steaming for 15 min to prepared idli.[29,30]

NUTRITIONAL PROFILE OF IDLI

The significant nutrition improvement in idli such as protein and vitamins, especially B-complex vitamins, increases as compared to its unfermented raw ingredients. The taste of idli depends on the type and proportion of raw materials and the properties of batter.[31] Nutritional profile is depicted in Figure 1.

HEALTH BENEFITS OF IDLI

The fermented food idli plays a key role in weight loss management and antiobesity. Other benefits also seen where

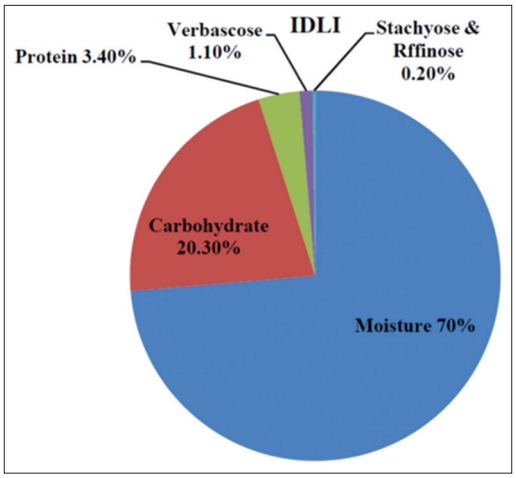

Figure 1: Nutritional composition of idli (Modified, Ray *et al*., 2016)

it reduces the cardiovascular diseases, stroke, and risk of high blood pressure. These also can be used as dietary supplement in calorie malnutrition and to treat the children suffering from protein kwashiorkor. These also act as vehicle for delivery of micronutrients such as folate, calcium, zinc, and iron which deliver nourishment to the muscle and bone, prevent anemia, and facilitate the oxygenation of blood. The proper digestion and bulky stool feelings are due to the dietary fiber content of idli.[21]

ANGIOTENSIN-I-CONVERTING ENZYME (ACE) INHIBITORY AND ANTIOXIDANT ACTIVITIES OF IDLI BATTER AND IDLI

The decapeptide angiotensin-I is an inactive peptide get activated by ACE (dipeptidyl carboxypeptidase) which breaks the peptides from carboxyterminal, results in the formation of octapeptide angiotensin-II that increases the blood pressure in the body. These can be lower using ACE inhibitor drugs, but many side effects such as allergies, cough, and skin rashes are observed. Recently, more research interest is created to derived natural ACE inhibitory peptides from food to lower the risk of side effects from synthetic drugs.[32,33] Another interest is to produce antioxidant peptides to neutralize the radicals due to awareness in consumer about synthetic antioxidant.[34-36] Bhaskar and Ananthanarayan (2019) used enzyme alcalase treatment (100–700 U/g batter, 30°C, 14 h) along with the fermentation for the production of more (potent) ACE inhibitory and antioxidative peptides.[37] The author suggested to consumed three idlis treated with 600 U alcalase/g batter which gives the benefits of Ramipril (synthetic ACE inhibitor) shows IC_{50}=2.08 ng/mL.

CHARACTERIZATION OF IDLI QUALITY STARCH, DAIDZEIN, AND TRYPSIN INHIBITOR ACTIVITY AS AN INDICATOR FOR ESTIMATION OF PROPORTION

Nowadays, readymade market for idli batter is grooming due to the time-consuming process. The apt ratio of rice and black gram is 3:1 that is used for the preparation of idli and it is justified by Rekha and Vijayalakshmi (2011).[30] However, due to cost difference and always variation in the cost of rice and legumes, the optimum standard can be varied. As such, there is no method for quantification of standards of idli for the variation in the rice and black gram.[38] Amane and Ananthanarayan (2018) developed robust method on the basis of starch, daidzein, and trypsin inhibitor activity that is used as an indicator to estimate the amount of rice and black gram.[39] Authors reported the increased in the starch content by increasing rice in the proportion and by decreasing the daidzein and trypsin inhibitor activity with decrease in black gram.

BIOGENIC AMINES DETECTION

Biogenic amines are toxic if it goes above safe level. Fermentation process enhances the formation of biogenic amines due to the metabolic activity which is associated with the microbes and the black gram which is rich source of proteins. Regubalan and Ananthanarayan (2019) estimated the biogenic amines (histamine, tyramine, putrescine, cadaverine, spermidine, and spermine) in the fermented food idli using high-performance liquid chromatography technique.[40] Spermine and histamine are absent in all fermented batter. The biogenic amine can be reduced with increasing the content of rice in idli batter.

SHELF LIFE OF IDLI

The Indian market for idli batter has been flourished from the past few years with production of 55,000 kg of batter per day[41] and deliver to consumer in small packets through distributed agency and retail outlets. A survey for storage of the idli which carried by local distribution outlets shows that the storage life of idli batter is at least 5–7 days for the refrigeration temperature (4–8°C) to inhibit the growth of microbes. During the distribution, bursting and puffing of pocket observed, in which major issue is during the storage and distribution of idli batter it is due to over fermentation of the batter by wild indigenous activity of microbes and unsuitable condition of storage of the batter. Sometimes idli's batter is sour in taste due to the high acidity and also the separation of whey observed which affects on texture of finished products that result in hard idli.[42] To extend the

Table 1: Effect of various treatments on idli quality: Work done till date

Ingredients	Treatment	Microbial analysis	Significance	References
Parboiled rice and black gram dhal (3:1)	Alcalase (100–700 U/g batter)	Natural fermentation, confirmation with LAB count, and yeast count	Decrease in viscosity and batter volume Increase in free a mino nitrogen content Increase in radical scavenging activity ACE inhibitory activity decreases	Maestri *et al*., 2015
Dehulled black gram dal and parboiled rice (3:1)	Replacement of rice with amaranth and finger millet from 25% to 100%	Natural fermentation (LAB, yeast count)	Improved bulk density with textural quality of idli Enhancement in antioxidant activity, amylase, reducing sugars, phytase activities, protease, soluble proteins, titratable acidity, and levels of microbial counts	Rani *et al*., 2019
Rice variety CR1009 and black gram dhal (3:1)	Addition of 10% of finger millet and pearl millet	Natural fermentation, total bacterial count, total lactic acid bacteria (LAB) count, and total yeast and mold count	Reduced fermentation time by increasing viable yeast, lactic acid bacteria, and total bacterial count Enrichment with dietary fiber and minerals	Chelliah *et al*., 2017
Rice and black gram dhal (3:1)	Electron beam irradiation at the dosage of 2.5 kGy, 5 kGy, and 7.5 k	Anaerobic bacterial count	Lowest irradiation dosage of 2.5 kGy with mild heat treatment to extend its shelf life	Mulmule *et al*., 2017
Rice and black gram dhal	Soaking	Natural fermentation	Decrease in anti-nutrient (hemagglutinating activity, trypsin inhibitor activity, and tannins content during soaking process except phytic acid which remains affected, but, further treatment with steaming reduce all activity including phytic acid	Sharma *et al*., 2016
Rice and black gram dhal	Addition of 30–50% barnyard millet	Natural fermentation	Wide variations in physicochemical characteristics Nutritional enhancement	Vanithasri and Kanchana, 2013

shelf life of idli batter, there is a need to identify the different antimicrobial agents which deactivates the activity of yeast and LAB after optimized fermentation time. Regubalan and Ananthanarayan (2018) employed the mustard oil essential which has biocidal effect at 40 ppm against CV and 80 ppm against LAB strains incorporated at 0.1% in idli batter which significantly reduced whey separation and batter volume and also retard the growth of yeast and LAB by measuring microbial count and extend the shelf life up to 30 days at 4°C.[43] Kannan *et al*. (2015) employed a new method of adding *Murraya koenigii* (curry leaves) to idli batter for increasing its shelf life. The addition of curry leaves powder increased the shelf life and also increased the texture, flavor, and appearance of idli. The calcium content was 10 times more than that of normal idli, even the dietary fiber content increased by 18.6%. This method increases the shelf life with low investment in India as curry leaves are native to India. Recent study on idli is summarized in Table 1.

CONCLUSION

There is no literature available on the scale-up of production of idli as ready to cook, not as ready to eat. The magic ingredient still needs to be innovated which improves the nutritional quality with excellent quality of idli. The more natural antimicrobial agent is need to find out which controlled the over fermentation process during the storage of idli batter. From the above literature, it is need to be find out effective processing technology such as freeze-drying which helps to develop ready to eat and maintain the quality of idli.

ACKNOWLEDGMENT

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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How to cite this article: Sonawane SK, Kandu VR, Patil S. An Overview on Characterization and Value Addition of Traditional Indian Fermented Food: Idli. Clin J Nutr Diet 2019;2(2):1-6.