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Research article

Production to consumption scientific manoeuvre of resource resilient food crop teff [*Eragrostis teff*]

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Abstract

Injera is fondly eaten continental food of two highland countries namely Ethiopia and Eritrea in north eastern Africa. Its preparation is based on fermentation of carbohydrates derived from local *gramini* family close growing crop **teff [*Eragrostis tef*]** in the fall/rainy season. In the fermentation process nitrogen content gets converted into nitrite, which largely gets removed in the preparation process to cause environmental problem. Nevertheless, some portion of nitrite still remains in the injera, which enters human body cell to act as a poison responsible for low life expectancy. In this study several improvements based on innovative application of scientific facts of environmental engineering from production of crop to consumption of food, are brought in.

The nitrite content will be removed from injera slurry base by addition of activated charcoal; crude charcoal plentiful available and used as cooking fuel. Additionally, the conventional setup used for fermentation is provided with tightly fitting lid having inner face covered with the charcoal coated textile. The nitrite production in injera is more when the nitrogen and phosphorus content of the grain *teff* is low. Innovative technology of the production process of *teff* is incorporation of legume crop in the sole injira crop to enhance uptake of nitrogen; phosphorus and sulphur. Thus, the quality of injira is made risk free and safe for consumption.

Key Words: Ethiopia, Eritrea, Injera, Soil conservation, Staple food, Nitrite, Cancer.

Introduction

Injera is continental staple food available in Ethiopia and Eritrea[1]. It is known to be a highly iron containing food, free of any gluten content and also preferred diet for patients of diabetic type II. The base material is obtained from teff (*Eragrostis tef*) a gramini family close growing crop during the fall (rainy) season. Injera grows well in degraded as well low fertility soil, under varying climatic condition from severe drought to short time flooded condition. The close growing crop controls soil erosion also. The straw of injera is used as cattle chaff feed. Its nitrogen and fertility requirement is very low, likewise the production potential is also low. The *teff* occupies fist position (about 28%) among cereal crop followed by area under maize (about 20%)[1]. In Ethioia the*Teff* is banned for export and price although high is stable. *Teff* is considered a crop fit for agricultural development in the drought prone countries of the world. Vast area of the plains of the country's can be utilized for cultivation of the *teff*.

The carbohydrates contents of teff is converted into slurry and subjected to fermentation for some days[3]. After some days of fermentation necessary addition of salts, peppers and spices are cooked in special furnaces in lots and large volume at a time. Once prepared injera is kept for days, till it is consumed, thus fermentation keeps on going. The injera forms meal with special type of vegetable containing, potato, cabbage and carrot. shiro [pulse powder cooked in semi paste form], green chili, when served with other added vegetables and dalls (cooked pulse splits) it gives cafeteria concept meal called popular dish *Bayanath*. Injira is also eaten with meat with different names of preparation. The *teff* is gaining preference in U.S. health food market due to its good content of iron, low content of carbohydrate and free from gluten. In addition to use of *teff* for injiea, it is used for preparation of porridge.

The novelty of injera base material and style of its preparation have traveled to USA also, where an enterprising Ethiopian has been running restaurants exclusively to serve injera, who has mechanical setup to produce 1000 injera per hour. Westerners and Europeans also eat injera with accepted justification of its being free from gluten and containing high amount of iron. This practice has become continental and there is hardly any botheration about its quality.

During the fermentation process, the N content of the *teff* gets converted into nitrite. The poisonous nitrite will remain in the injera, which will move to the human cell after consumption and keep on to continue to accumulate. With long time of consumption the content of the nitrite will obviously approach to the poison lethal level and become killer for the consumers[2]. As such there appears to be no knowledge about this defect and likewise any care to reduce the nitrite by any anti oxidant remedy. All effect of the injera is culminating in short span of life expectancy in these two nations. The scientific reason for development of nitrite during the fermentation is low N content. The nitrite develops when nitrogen and phosphorus content are low. It means there is need to look at the process of fermentation, preparation, nitrogen and phosphorus content, dynamics of fermentation and whether aerobic decomposition can do similar effect, as well[3]. It is presumably taken that this type of research investigations have not gone in to test quality assessment of injera. Since it is food material and directly connected with the health and life of the people, it demands careful and precise research study to look into the quality of injera.

The crop has been evolved by tradition and long time experience of use and due to special characteristics of growth habit of *gramini* family crop. Prospects of teff and problems with injera has not come to attention of the research scientists. Therefore, the production and food preparation has been reeling on the traditional knowledge. This new knowledge focusing the real cause of environmental process of fermentation has not been looked at from content consideration point of view. So far people highlight its ruggedness of growth under poor land and fluctuating hydrologic condition[1]; no research and development appear to have been paid towards the quality improvement of injera. The field experiments with no adequate field and laboratory facilities are not likely to produce precise results. The first author has undertaken several studies on management of nitrogen (N), sulphur (S) and hydrologic cycles to enhance productivity and protect environment. Thus, it became imperative to think about the innovative application of scientific facts to ameliorate the problems associated with the production of teff to consumption of injira. The objective of our study was to look into process of science of fermentation as well as production and synthesize method for removal of the problem connected with development of poisonous nitrite in injera.

Research Endeavors

The study was taken to apply the scientific principle of environmental engineering on fermentation of carbohydrates with low content of nitrogen. The fermentation of the injera slurry goes anaerobically, where methane is the main green house gas emission having global warming factor of 21 as against that of carbon as 1[4]. There is no concern on the emission of green house gas [GHG] from injera preparation in these two high land countries in particular and other such countries of the world in general. In this strive there is also equally no awareness about the development of nitrite. These facts are well known in the environmental engineering phenomena. However, no experimental measurements were conducted. Based on the innovative application of the scientific principles in the style of preparation of injera as well as the production of *teff* are devised which will certainly improve the quality of injera and free from such poison content[4].

Scientific Findings

[A]. Removal of Nitrite from the Injera Slurry

The authors detail study on the management of nitrogen cycle has enabled several innovative application possibilities for improving the quality of injera by the refinement in the process of preparation as well as production of good quality of teff.

In the fermentation process nitrogen content of the slurry of the *teff* follows the reaction towards formation of nitrite[4]. Nitrogen inreaction with water gets converted in to nitrite and releases hydrogen ion. In the later reaction the hydrogen ions combine with carbon to form the methane (CH_4)

$$N_2 + 6H_2O = 2NO_3^- + 12H^+ \quad (1)$$

Reaction 1 occurs when nitrogen and phosphorus content is low in the slurry under fermentation. Concentration of NO_3^- increases in human cell and with time its accumulated content exceeds LD_{50} (lethal dose 50 at which 50 % of population dies) also, it causes problem of cancer[2].

Since injera has acquired its demand, concern research attention of food microbiologist and food biotechnologist are required to reduce nitrite in injera and release of GHG nitrous oxide. Enforcement of principle of environmental engineering ie carrying out the absorption and adsorption of toxic salt and gasses, respectively by activated char coal will be easy and workable practical solution to the problem[3]. This function requires very little modification in the conventional fermentation setup, which will have absorption of toxic salt in injera and adsorption of methane and nitrous oxide which go to join the atmosphere. Although such low quantum of adsorption of GHG may be considered of low significance from environment conservation point of view, improvement in the quality of injera is important. Removal of nitrite will mean reduction in the risk of the problem of cancer on account of eating poor quality injera. Prevalence of use of char coal as a fuel / energy for cooking becomes an easy an accessible commodity for this small application. Preparation of activated char coal involves some sophisticated steps. Nevertheless, the available wood char coal with the makers of the injera can be activated and used for this purpose. The reactivation of the char coal can be done by steaming the old used char coal in house hold appliance having arrangement for steaming for cooking etc. Thus, the entire problem of removal of nitrite from injera will get solved by this sure and scientific way of absorption.

[B]. Enhancement of N and P of grain teff

Normally the *teff* is grown with minimum input of manure and fertilizers, as well as on the degraded land with low soil nutrition that means the produce of *teff* is obvious to contain low nitrogen and phosphorus content. In earlier study[4] of the first author detailed aspects of management of nitrogen cycle towards enhancement in the nitrogen and phosphorus content was dealt with many innovative practices included the crop banding[6] with some leguminous crop for agriculture crop, grasslands and forest and orchards[4-5]. The cultivation of *teff* is very similar to the growing grasses in the grasslands. In this situation, regular rows of *teff should be inter cropped*

with suitable legumes at certain intervals throughout the field. Nitrogen fixed by the leguminous crop will get transferred to the *teff* that will enhance the nitrogen content of the teff[5]. Application of specific type of manure which is the aerobically decomposed cellulose and organic waste [NADEP Compost] will enhance uptake of phosphorus and potash by the crop. Thus, the content of N, P and K will get increased which in due course of processing and preparation of injera will eliminate formation of nitrite. Both the aspects of reduction of nitrite by enhancement of content N and P and by absorption by activated char coal are supplementary in sequential steps. The cumulative effect will make injera totally free of nitrite. Thus, the injera prepared will be nutritious food free from any health risk of cancer. This quality building and defect removing scientific fact based improvement measures will go definitive and long way in improving any food preparation based on fermentation and and pan cooking such as injera and Indian *recipe dosa*.

[C]. Pros and Cons of research endeaour

The two methods viz the improvement in the process of fermentation and cultivation practice of injera for enhancing N and P content of injera grains, suggested in this study above are based on innovative application of scientific facts of nitrogen cycle and physical processes of absorption /adsorption by activated char coal. These methods will work under all conditions and produce results with surety of success. Since there have been no research effort towards realization of the problem of nitrite and related cancer, there have also been no effort on the research work. This study opens a door for the research scientists to take inspiration and carry out researches on the line towards optimization of the measues for improvement of *teff* production and injera cooking. This universal application of the research approach will give results for local optimization which can be further improved upon to enhance the quality and production of both *teff* and injera.

Because, *teff* belongs to gramini family, it grows very fast, demands low volume of water, protects land from erosion, contains iron and other nutritional minerals for human body, requires less energy for cooking, suffers no problem of insects, pest and bird damages either in the field or in storages, can be kept for maintaining food security under changing scenario of global warming and climate change[7,8,9]. It will be ideal approach to sow all barren land susceptible to splash, wash off and rill erosion with the *teff* and harvest grain to the extent possible for human consumption, let it be eaten by cattle grazing. The *teff* stalk left on ground will provide surface cover to protect erosion, arrest sediment at site and produce filtered water for storage in the water reservoirs. Thus, water bodies will get saved from siltation and better clean reservoir water will need less intensive treatment for domestic water supply[9]. Thus, *teff* will work as a famine relieving crop and food resource to make world free from the worry of risk in the food insufficiency. Therefore, this research has given a globally applicable least cost involving method for ensuring prevention of famine and health risk of cancer. The same technology can be applied for production of enhanced quantity and quality of other nutritional crops[5] with respect to enhancing uptake of N,P,K, in other crops viz wheat, pearl-millet, guinea corn, maize, potato and sweet potato. The first authors developed a new green technology named Racy Nature Agriculture[5] which is universally applicable for all the crops and for both irrigated and rain fed crop production condition[5,7]. In this technology all these measures are inbuilt which produce high quantity, better quality than general agriculture and protect environment. Further, research is needed to quantify the quality buildup by application of Racy Nature

Agriculture[5]. It is well known fact that enhancement in nitrogen and sulphur will improve the amino acid content and quality, which form the protein necessary compound for nutrition and good health.

The use of activated charcoal will adsorb toxic salts and harmful gases dissolved in fermented food. The activated wood charcoal will be useable several times with pre activation in the simple steaming vessel such as pressure cooker and rice cookers. Thus, there is nothing to buy from market or to invest for it. What has been for the definite is more than conceptually expected from field experiments? While this scientific research is universally true and applicable, the field experiment will help derive results on interactive effect of local factors. This research will guide one to make broad policy. The local alteration viz optimization of doses of leguminous crops in teff and adding charcoal in slurry can be fixed by the field experiments.

Conclusion

The study devised improvement methods for production of resources resilient crop *teff* and food preparation of injera, at present continental food for Ethiopia and Eritrea, free from any serious and dangerous health risk of cancer. The technology makes the *teff* as a global famine risk remover towards food in future, which might occur due to extremities of the global warming and climate change. Sowing of exposed and barren land surfaces with *teff* will work as no cost involving sediment arresting conservation savior for the globe.

Reference

[1] The Ethiopian Herald, 2014, Ancient crop with modern potential: Teff, Feburary 21, 2014, 10.

[2] Horobin, Wandy (ed), 2003, Poison, How it works : Science and Technology, Scavandis Carporation, USA.

[3] Yadav, R. C. 2012. Innovative application of scientific facts for nutrient recovery from waste water streams for sustainable agriculture and protection of environment, Hydrology: Current Research. (5): 1000142 (2012).

[4] Yadav, R. C. 2014. Innovative application of scientific facts for arresting GHG-N_2O and improvising lucrative ventures with enhanced land, water and nutrient use efficiency, The Journal of Energy and Environmental Science. Photon 128 : 486-520

[5] Yadav, R. C. 2013. Racy nature agriculture versus other a like technologies: A technologies contrast. American Eurasi J Agri and Environ.Sci. 13 (10) :1420- 1439.

[6] Yadav, R. C ; Om Parakash and Deshwal, J.S; 2013. Biotechnology of Intra - Row Banding of Cyno-bacteria Leguminous crops for raising yield plateau of cereals and oilseeds Intern, J. Agronomy and Plant Production, U.K., 4(12) : 3330-3336.

[7] Yadav, R.C. 2014. Drainage Engineering: A savvier for sustainable resources use, protection of environment and professional development, Journal of Civil Engineering- Photon 107: 200-213.

[8] Yadav, R. C; 2013. Innovative applications for scientific facts for zero methane emission and enhancing productivity of paddy fields for sustainable global food security: A conceptual model, Frontiers of Environmental Sciences and Engineering, USA. December,2013.

[9] Yadav, R. C; 2014. Sediment transport model for innovative global arable landform of integrated conservation technology: New research dimension, ICCE 2014, Sediment transport dynamics from summit to sea, December 11-14, 2014, New Orleans, USA. (Accepted for presentation).