



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 13, April 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Overview of the Innovations Developed for a Sustainable Environment

Angeline S¹, Fathima Asma Y², Kaavya J³

U.G.Scholars, Department of Food Technology, ACTech, Anna University, Chennai, Tamil Nadu, India^{1,2,3}

ABSTRACT: Food and food systems are constantly evolving to support a environment friendly sustainable food security. Future foods like air protein, vegan milk, in-vitro meat and many more innovations are revolutionizing the production and consumption of food around the world. Future foods not only have immense potential to better the health of millions of people and cater to the needs of various diets but also provide game-changing, positive impact on our environment by reducing dependency on natural resources, carbon emissions, livestock and other aspects. By doing so, it addresses the climate crisis and the food demand of the ever-increasing population in a safe and sustainable manner. In this paper, we aim at discussing the role of such innovative foods and digital technology like 3D food printing that have the potential to provoke deep changes.

KEYWORDS: Sustainable, innovative, future, alternative proteins, environmental impacts, reduction of waste, health benefits, population increase.

I. INTRODUCTION

According to a survey, the world population is expected to reach a high mark of 9.5 billion. This population growth along with urbanization will result in exerting high pressure on global resources for production and availability of more food[1]. Thus, resulting in a negative environmental impact like high carbon emissions, exhaustive use of land, water and other natural resources. Therefore, using innovative alternative sources to meet food requirements is the next milestone in achieving a sustainable and healthy planet. As more and more people are becoming health and environment conscious, it increases the demand for sustainable food sources[2].

II. RELATED WORK

Lomartire et al (2022) has concluded that pure phycocolloids are not suitable for commercial packagings and addition of plasticizers are necessary and seaweed packagings provide a sustainable packaging material. Peng et al (2019) conducted experiments and successfully concluded that chicken feathers, which are considered as waste products can be converted into amino acids and antioxidant substances via microbial degradation. Gautam. K et al (2021) have concluded via experimental data that the best food to incorporate algal protein were tortilla chipa, khakhara and energy bars and that further research is needed to refine the products. Bonnaillie. L. M. et al (2014) have concluded that, although, casein film packaging provide a viable alternative, further research has to be done on to optimise it's formulation to make it more durable and resistant, as the film performance depends on various surrounding and system parameters[3]. Roy. B. et al (2021) has discussed the advantages - a more sustainable alternative and the disadvantages - less cost effective, of lab grown meat and concluded that it is too early for it's commercialization and thus more research has to be done in the field. Sergelidis. D (2019) has mentioned that lab grown meat can provide an alternative to the traditional meat sources and contribute to sustainability but more research and consumer awareness and ethical acceptance is need for commercialization of the product[4-5]. Pitayachaval. P et al (2018) have discussed the advantages and disadvantages of 3D food printing techniques such as extrusion based printing, inkjet printing and binder jetting. Kumar. M (2019) has mentioned the preparation and antioxidant properties and health benefits of Paruthi Paal, an ethnic food of south India which can also be used as a protein supplement. This. H (2013) has discussed about the role of molecular gastronomy in self-contained packaging and it's contribution to the sustainability. Cura. E. D et al (2020) have discussed a highly sustainable alternative form of microbial protein called air protein and it's role in developing a sustainable environment[6-7].

III. METHODOLOGY

Chicken Feather Protein

Billions of tonnes of chicken feathers are wasted every year all over the world. Chicken feathers at their core are chemically 90% protein (keratin), making them an excellent sustainable protein source. Even though the feathers contain enzymes that are almost similar to the meat of the chicken, the raw inedible and indigestible feathers can be chemically

digested and molded into any kind of animal meat like beef, chicken, fish, caviar, translucent wraps, cracker like crisps, etc[8]. The feathers are chemically modified to resemble the "melt in the mouth feel" of their animal counterparts. They can also be minced, ground, cooked or processed like the conventional meat products. Although it has not entered the mainstream market yet, it is an innovative and environmentally conscious source of protein. The process of converting chicken feathers into "meat" takes about 13 steps. The main steps include cleaning, pulverizing and the important step of breaking down the keratin by acid hydrolysis using keratinase enzyme. The mixture is then heated for 24 hours and cooled. This results in a flavourless highly sustainable protein that can be modified into anything[9].

Air Protein

Air protein is the most sustainable form of protein as it uses gases in the air to make the protein and its production requires virtually no agricultural land. It is made from CO₂ emitted from factories and other sources. Air protein is developed in fermentation vessels designed specifically for its manufacture where microbes combine the CO₂ in the air with water and nutrients to form a nutrient rich neutral tasting high protein flour. This flour also contains all the essential amino acids and the vitamin B complex[10]. This flour is versatile and can be used as a raw material to make different food like pasta, roti, etc.

Lab-Grown Meat

Lab-grown meat, also known as cultivated meat or cultured meat is produced by culturing animal cells in vitro. It is a form of cellular agriculture. Cultivated meat is made of the same cell types that can be arranged in the same or similar structure as animal tissues, thus resembling the sensory and nutritional profiles of conventional meat. In the 1950's, Dutch researcher Willem Van Eelen independently came up with the idea for cultured meat, but it was in 2013 that the first lab-grown meat was invented by Dutch Pharmacologist, Mark Post.

The process of making the lab-grown meat begins by extracting the stem cells from biopsy of live animal. Stem cells are totipotent in nature and are able to differentiate into different cells like muscle or fat cells. The cells are grown in bioreactors at high densities and volumes, similar to the conditions within an animal body. The cells are fed with oxygen-rich cell culture medium like plant or animal-based serum made up of basic nutrients such as amino acids, glucose, vitamins, and inorganic salts, supplemented with growth factors. Cells grow and naturally merge to form myotubes which leads to formation of trillions of strands or fibers which are attached to a sponge-like scaffold that floods the fibers with nutrients and mechanically stretches them so as to increase their size and protein content[11].

It is a tasty and nutritious alternative meat option that is slaughter free. It is hormone-free as the meat is grown under laboratory conditions; the meat is free from any artificial growth hormones that are typically used to grow conventional meat. Since it is grown under sterile conditions, there is a very low risk of contamination and use of antibiotics as used for conventional meat. Cultivated meat drastically reduces the use of land, water and other natural resources. On the other side, the challenges faced are that scientists are trying to overcome the type of culture medium used, as it involves the use of Fetal Bovine Serum, that is obtained from the blood of a dead calf which is not only expensive but also contradicts the slaughter-free label of the lab-grown meat. It raises concern by various religions about its consumption. Many countries are still in the research and development phase of cultivated meat and have a long way to go before it reaches the mainstream market.

Algae Snack Bar

Algae refers to any water-dwelling eukaryotes capable of photosynthesis whereas Spirulina (small-spiral) refers to spiral shaped, green color microalgae which naturally grows in the wild in warm, fresh-water lakes. The algae snack bar is a microbial protein bar made up of various ingredients like hemp, chocolate or dates, sunflower seed butter, syrups and healthy ingredients of choice but the core ingredient of it is Spirulina. Spirulina has excellent nutritional profile as it is richest natural source of plant-based protein (contains 50%-60%), iron, vitamins, minerals, B-12 and pro-vitamin A. The Spirulina snack bar has high quality proteins and thus provide a nutritious, sustainable and a wholesome food option. Algae (Spirulina) based foods become even more essential as more and more people around the world are becoming health conscious, focusing their diets strictly be plant-based. The snack bar is ideal and caters to the needs of vegan, gluten and lactose-free diet. It is a more sustainable source of high quality protein and energy as it reduces the dependency on land, water and other natural resources etc. that play a critical role in the climate crisis and also meets the food requirements of ever-increasing population.

Spirulina is largely available as food supplement in the form of green powder or tablets in the market. In India spirulina is sold in the market as Chyawanprash. Consumption of spirulina comes with plethora of benefits like it has powerful antioxidant activity, balances body's pH thereby reducing inflammation throughout body in a safe and chemical -free way, calms nerves and helps fight stress, improves gut health, easily absorbed by the body, regulates blood sugar levels,

activates metabolism, strengthens immune system and the list goes on. In 2018, an Dutch-Italian startup, The Algae Factory, established with the idea of developing a snack bar using dark chocolate and spirulina.

Cotton Seed Milk

Cottonseed milk is a beverage obtained from cotton seeds that is commonly consumed by the people of TamilNadu , locally known as Paruthi Paal. Cottonseed milk is rich in protein, essential fatty acids and sugars and it's regarded as a "triple nutrient" for the same. Cottonseed milk is ideal for those who are lactose intolerant and vegan. Since cottonseed milk is extracted from the cotton seed which is by product of cotton processing, it is a better, more nutritious and sustainable alternative source.

Cotton seed milk is extracted by soaking cotton seeds overnight and washing them thoroughly, then it's blended, mixed and filtered using a muslin cloth. It is advised to remove a phenolic compound called gossypol from extraction since it's toxic and not suitable for drinking.

Cottonseed milk and its products are consumed for its versatile health effects such as:

- Healing stomach ulcer
- Excellent source of antioxidant and anti-ageing effects
- Treatment for cold and cough
- Inducing sleep
- Maintaining blood pressure
- Regulating menstrual cycle and prevents PCOS
- Helping prevent cancer

Hence, cotton seed milk is a simple and sustainable novel health product that can be used an alternative source to traditional milk, as a protein source, etc..

3-D Printed Food

3D food printing is manufacturing food products using equipments like lasers and inkjet where food grade syringes deposit food layer by layer. Chocolates and cookie dough were the first 3D printed food materials by Cornell University in 2006. Over the years pasta, meat substitutes, seafood products like salmon slices, seaweed, chocolates of unique shapes etc. Have been successfully 3D printed. 3D food printers can provide us with personalized nutrition. Anrich3D is one such 3D food printer based on a Singaporean startup which provides the feature to customize meals at scale.

Benefits:

- 1) It can be used to print food that is entirely customized based on the consumer's preferences, diets, health conditions, allergies, etc.. The portions and the measurements can also be modified based on personal preference.
- 2) It is used in hospitals to provide multi-nutrient food based on the patient's required percentage of carbohydrate, protein, fats and other essential nutrients based on the patient's age, height, weight and other characteristics.
- 3) Food products of increased precision and quality can be developed.
- 4) Food is produced at ease and at low costs.
- 5) 3D food printing reduces food wastage, since it uses only the right amount of ingredients and hence it is highly sustainable.

Self Contained Food

Self-contained yogurt balls are blob-like food that make our meal mess free. It is prepared by molecular gastronomic method of spherification. In spherification method, any soft food can be transformed into ball forms. When mixed with sodium alginate, thin-walled balls are formed as it comes in contact with aqueous calcium, which when we eat, will just pop inside our mouth. It also reduces a huge amount of packaging waste due to its self-containment. Hence, it's a sustainable and environment friendly product. Other examples of foods which can be prepared by spherification and self contained are instant ice cream, spaghetti from vegetables, fake caviar made of olive oil etc..

Seaweed as Edible Packaging Material

Seaweed is a marine alga that grows up to 45 meters in a short span. Seaweed has hydrocarbons that can be easily extracted to manufacture bioplastics. These seaweed bioplastics are 100% biodegradable and completely safe to consume. Seaweed cultivation requires no arable land, fertilizer, pesticides or even fresh water. It can be grown in the sea with the nutrients that are already present in seawater. Seaweed also captures carbon twenty times faster than trees and their farms boost fish populations, making its carbon print significantly less than the other packaging materials. The seaweed is cultivated, harvested and dried under the sun for 36 hours . It is then ground, washed with pure water and dissolved in solvents. The solvents are then evaporated in a continuous rotary evaporator resulting in a viscous gel like substance that can be poured, molded and set into any shape and size. When the set "plastic" is stretched, it can be made into edible bioplastic wraps. It

Organized by

Dhaanish Ahmed Institute of Technology, KG chavadi, Coimbatore, India

can also be molded into edible seasoning packet of instant ramen, tea bags, straws or virtually into any single use plastic counterpart. This seaweed can also be used to make plastic bags which are highly durable and sustainable. The seaweed plastic is aimed to replace the thin plastic film coating used in fast food wrappers, coffee cups, paper cups, paper plates, etc. that make them grease proof and waterproof, making them truly biodegradable and sustainable. Seaweed plastics can also be used to replace water bottles by encasing water or any liquid in a thin film of the modified seaweed, which is edible, thus eliminating the need for plastic bottles.

Seaweed plastics are also compatible with current manufacturing equipments, so companies don't have to invest in new machinery to accommodate them. This is aimed to accomplish by selling the set seaweed plastic pellets to the companies, from which the companies can make any type of packaging material desired. India is suitable and highly compatible to produce seaweed plastics as enormous amounts of seaweed naturally grow or cultivated in its vast coastline and has the capacity to fulfill the manpower equipped with knowledge required to cultivate and carry out the initial processing of the seaweed before its chemical modification.

The seaweed plastics can be dissolved in boiling water in a matter of minutes; in sea, they are dissolved within a couple of hours, and they degrade within a few months in a compost which can be used as a fertilizer for plants. They also emit significantly less CO₂ when degrading. The only downfall of seaweed plastics is that they are high in cost. Hence, seaweed plastics are by far the most sustainable and edible packaging material available.

Casein- Edible Food Packaging

Casein and whey proteins are the two types of proteins found in cow's milk. They are high quality proteins containing essential amino acids and they are widely used for large-scale preparation of various foods like cheese, cream and yoghurt, not only that casein can be also used as biopolymers to produce biodegradable, sustainable and edible packaging material. The method of producing casein film involves mixing of an aqueous solution containing volatile carboxylic acid, plasticizer and deionized water along with casein causing the milk to swell and then deforming the swollen mixture at temperature from 60 –100 c, it is then solidified to form film or film tube by treating with an aqueous hardening solution. The standout feature of casein film is that they are 500 times less porous than starch-based film making it a more effective oxygen barrier, therefore reducing food spoilage when compared to plastics.

Casein film can be widely used as wraps or pouches for sausage casings, packaging material for non-hygroscopic, powdery or fat-containing products, packaging tablets etc. Scientists are also working on to create single serve food wrapping of casein films to make coffee or soup sachets as casein film can readily dissolve and reduce wastage. The major drawback is that casein films are not durable as they readily dissolve in water and other solvents. To overcome this citrus pectin is added to the film formula to make the film more resistant to humidity and warmer temperatures. Consumption of these films also raises concern about their hygiene as it does not guarantee that the packaging remains sterile throughout the distribution process, this is due to the fact that it is in the initial stages. But with more research and experimental studies, these films could turn out to be the most efficient, easily available, cheap and eco-friendly edible packaging material in the future.

IV. CONCLUSION

Food and food system innovations is taking place at a rapid pace to satisfy the evolving needs of consumer demands and expectations, at the same time it also creates opportunities to create, grow and expand food businesses to make it possible to develop nutritional, sustainable and tasty foods. These innovations become critical with the rise of the 'vegan' era, as more and more people are becoming aware of the importance of using sustainable and eco-friendly food sources. Food innovations not only represent food of the future but also provide amazing alternatives for various food sources that are tailored carefully to best suit the consumer needs and sometimes even better than the conventional ones. Though the innovations and technology are developing according to the increasing population, some people still prefer conventional foods and are not ready to accept the substitute very easily. Newly developed products are not readily accepted by most of us. For instance: we find it unconvincing in the aspect of taste and appearance of lab-grown meat and Paruthi Paal etc. when compared to the conventional ones but given the immense potential of these innovations, it could create wonders to sustain as well as satiate our planet.

REFERENCES

- [1] Lomartire, S.; Marques, J.C.;Gonçalves, A.M.M. An Overview of the Alternative Use of Seaweeds to Produce Safe and Sustainable Bio-Packaging. Appl. Sci. 2022, 12, 3123. <https://doi.org/10.3390/App12063123>
- [2] Zheng Peng, Xinzhe Mao, Juan Zhang, Guocheng Du, and Jian Chen. Effective biodegradation of chicken feather waste by co-cultivation of Keratinase producing strains. Peng et al. Microb Cell Fact (2019) 18:84 <https://doi.org/10.1186/s12934-019-1134-9>.



Organized by

Dhaanish Ahmed Institute of Technology, KG chavadi, Coimbatore, India

- [3] Kshipra Gautam, Ashish Waghmare, Niraja Soni, Aniket A Teredesai, Manish R Shukla, Santanu Dasgupta. Algae protein enriched nutritious snacks and their sensory evaluation. *Journal of Food Science and Nutrition Research* 4 (2021): 202-212.
- [4] Laetitia M Bonnaillie, Han Zhang, Serife Akkurt, Kit L. Yam and Peggy M. Tomasula. Casein Films: The Effects of Formulation, Environmental Conditions and the Addition of Citric Pectin on the Structure and Mechanical Properties. *Polymers* 2014, 6, 2018-2036; doi:10.3390/polym6072018. <http://www.mdpi.com/journal/polymers>.
- [5] Bedanta Roy^{1*}, Abhirame Hagappa², Yanasha Devi Ramalingam³, Nandikha Mahalingam⁴, Asra Banu Shaik Alaudeen⁵. A Review on Lab-grown Meat: Advantages and Disadvantages. *Quest International Journal of Medical and Health Sciences*. QIJMHS 2021;4(1):19-24.
- [6] Daniel Sergelids. Lab Grown Meat: The Future Sustainable Alternative to Meat or a Novel Functional Food?. *Biomed J Sci & Tech Res* 17(1)-2019. BJSTR.MS.ID.002930
- [7] Paphakorn Pitayachavall¹, Nattawut Sanklong¹ and Anantapoom Thongrak. A Review of 3D Food Printing Technology. *MATEC Web of Conferences* 213, 01012 (2018) ACMME 2018 <https://doi.org/10.1051/mateconf/201821301012> .
- [8] Manoj Kumar, A Nutrient-Rich Healthy Drink from Cottonseed: An Indian Delicacy. *Journal of Ethnic Foods*. <https://journalofethnicfoods.biomedcentral.com/articles/10.1186/s42779-019-0035-1>
- [9] This, H. Molecular gastronomy is a scientific discipline, and note by note cuisine is the next culinary trend. *Flavour* 2, 1 (2013). <https://doi.org/10.1186/2044-7248-2-1>
- [10] Dilek Ercili-Cura, Anna Häkämies, Laura Sinisalo, Pasi Vainikka and Juha-Pekka Pitkänen, Food out of thin air, *Food Science and Technology* Volume 34, Issue 2/ p. 44-48, 28 May 2020. https://doi.org/10.1002/fsat.3402_12.x



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details