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3D PRINTING TECHNOLOGY, IT'S USE AND MEDICINAL IMPORTANCE IN FOOD INDUSTRY – A REVIEW

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Abstract

Three-dimensional (3D) printing technology was invented 1986 by CHUCK HULL in the USA. It is the process of manufacturing food products using a variety of additive manufacturing techniques. Most Commonly, food grade syrings hold the printing material, which is then deposited through a food grade nozzle layer by layer. The most advanced 3D food printers have pre-loaded recipes on board and also allow the user to remotely design their food on their computers, phones, or some devices. The food can be customized in shape, colour, texture, flavour or nutrition which makes it very useful in various fields such as space exploration and health care. In recent years, 3D Printing is widely used in the world. 3D printing technology increasingly used for the mass customization, production of any variables of open-source designs in the field of agriculture, in healthcare, automotive industry, locomotive industry and aviation industries. 3D printing technology can print an object layer by layer deposition of material directly from a computer aided design (CAD) model. This paper presents the overview of the types of 3D printing technologies, the application of 3D printing technology and lastly, the materials used for 3D printing technology in manufacturing industry and medical field. In medical field most common technology used for 3D printing is powder bed fusion. Powder bed fusion is commonly used because it works with a variety of materials used in medical devices, such as titanium and nylon. It is a synthetic thermoplastic linear polyamide and is the most common plastic material. It is a well-known 3d printing technology.

Medical uses for 3D printing, both actual and potential, can be organized into several broad categories, including tissue and organ fabrication; creation of customized prosthetics, implants, and anatomical models, and pharmaceutical research regarding drug dosage forms, delivery, and discovery.

Keywords: Food extrusion, Customized food, Micro structural properties, Nano bio materials, Food layer manufacturing, Rapid prototyping, Additive manufacturing, Thermo- mechanical properties.

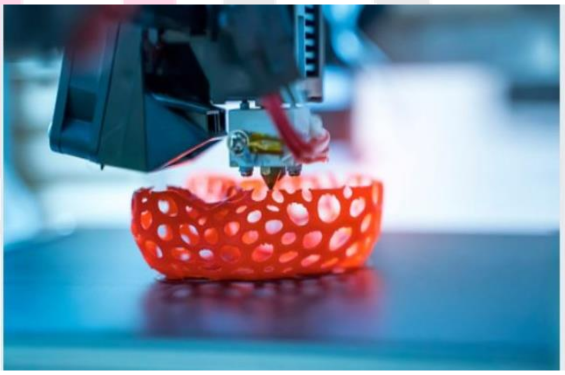
INTRODUCTION:

Three-dimensional (3D) printing technology was invented 1986 by CHUCK HULL in the USA. It is the process of manufacturing food products using a variety of additive manufacturing techniques. Most Commonly, food grade syrings hold the printing material, which is then deposited through a food grade nozzle layer by layer. The most advanced 3D food printers have pre-loaded recipes on board and also allow the user to remotely design their food on their computers, phones, or some LOT devices. The food can be customized in shape, colour, texture, flavour or nutrition which makes it very useful in various fields such as space exploration and health care [**1**].

It is known as additive manufacturing or rapid prototyping, whereby products are built on a layer – by - layer basis through a series of cross- sectional slices [**2**].

It is a technology that produces three- dimensional objects using stacked layers using a computer model programme and was invented to produce a complex structure of high polymer materials **[3].**

Food 3D printing technology is gaining attention **[4]**.



It can process and produce different designs using ingredients such as meat, chocolate, candy, pizza, dough, cotton and sauce industry **[5].**

Three- dimensional food printing technology can control the type and amount of ingredients that can determine the amount, nutrient and flavour characteristics of ingredients, enabling personalized food production **[6].**

In the post-covid era, 3D food printing technology is expected to increase demand for the development of customized personal foods for special diets such as athletes, children, pregnant women, patients etc **[7].**

These 3D printing techniques allow the process to proceed with the structure and shape of personalized foods by adding specific ingredients selected by personal preferences **[8].**

The 3D printing technology represents a big opportunity to help pharmaceutical and medical companies to create more specific drugs, enabling a rapid production of medical implants and changing the way that doctors and surgeons plan procedures **[9].**

Medical uses for 3D printing, both actual and potential, can be organized into several broad categories, including tissue and organ fabrication; creation of customized prosthetics, implants, and anatomical models; and pharmaceutical research regarding drug dosage forms, delivery, and discovery **[10].**

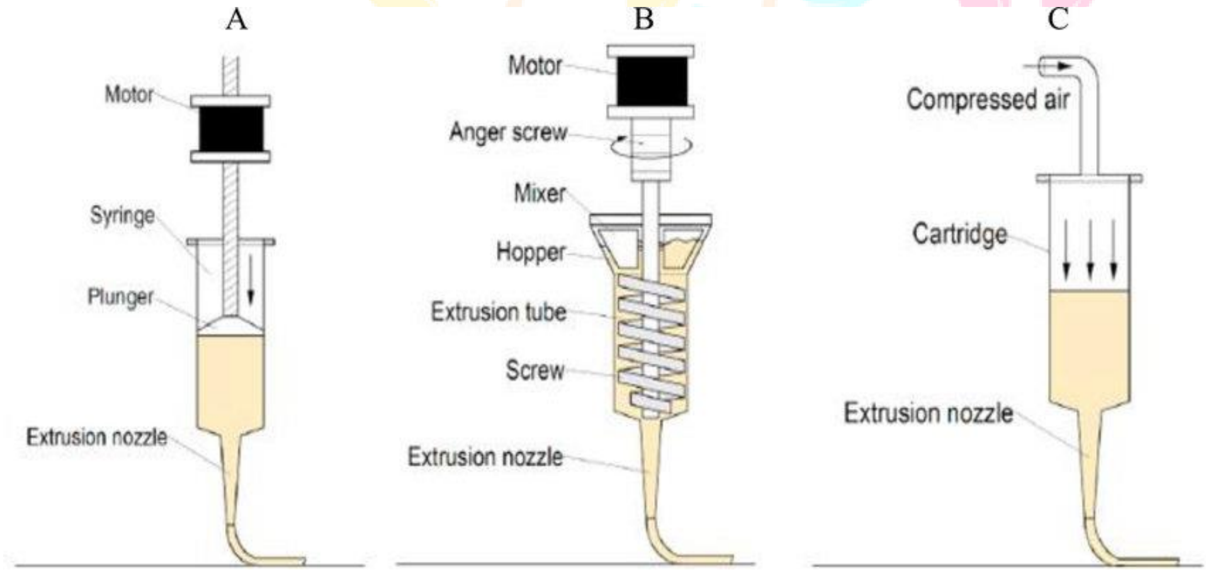


Figure1: 3D food extrusion mechanisms. (A) syringe-type extrusion (B) screw-type extrusion (C) air pressure-driven extrusion.

AIMS AND OBJECTIVES:

- The main purpose of this study is to know the new possibilities, such as personalized nutrition, automated cooking, reduction in food wastage in 3D food printing technology. We also know the medicinal importance by this study.

- To explore the benefits of 3D food printing technology in food industry and pharmaceutical industry as well.

- To know about the amount where 3D printed food can provide the control necessary to put a custom amount of protein, sugar, vitamins and minerals into the food we consume.

- To assess weather the 3D printing technology can be healthy and good for the environment because it can help to convert alternative ingredients.

- To gain knowledge about different creating spare parts of this three- dimensional (3D) food printing technology.

REVIEW OF LITERATURE :

- According to, Mantihal s. et al (2020), the three-dimensional technology directly applied to build a physical model from 3D modelling without any aid of model. It is also shown that 3D food printing (3DP) are possible to produce complex food model with unique internal pattern **[11].**

- According to, Yan Q. et al (2018), Shortages for organ donars transplantation are important clinical challenge in today's world. In many way 3D printing technology helps to solve this limitation. The technology can be used to quickly manufacture personalize tissue engineering scaffolds, repair tissue defects in situ with cells, and even directly print tissue and organs. 3D printing that are related to materials and to the construction of extracellular matrix in vitro for medical application **[12].**

- According to, Derossi A. et al (2016), 3D printing is a group of technologies of gain interest able for producing, a desirable shape of any kind of materials. **"customized food formula"** which refers to the preparation of different production of functional foods and input necessary nutrients to those products to prevent any kind of disease **[13].**

- Pandya K. et al (2021) had shown that, Three- dimensional printing has numerous applications in the food industry that may enhance diversity, quality, healthiness and sustainability **[14].**

- According to, Attaran M. et al (2020), 3D printing can revolutionize food innovation and production through better creativity, customizability and sustainability **[15].**

- According to, Lanaro M. et al (2017), 3D printing of foods can give an unique and complex shape to those food properties. Although the main character is fabrication parameters which helps to enhance the quality and efficiency of those food products. Several key fabrication parameters were investigated and optimised to enable printing complex 3D objects made from chocolate. The ability of an extreme chocolate fibre to span large distances without collapsing was investigated by adjusting variables such as movement speeds, extrusion rates and cooling rates **[16].**

- According to Dianez I. et al, (2022) Enormous capacity of 3D printing and 3D Food Printing over any other technologies, this is the main advantage of both technologies. Use of this technologies makes it possible to obtain products without any planning and implementing a costly and complex manufacturing process. This makes 3DFP a technology of choice for the preparation of food products that meet specific needs, such as controlled nutritional or rheological properties **[17].**

- According to Suryawanshi D. et al, (2022) 3D printing is an innovative technology for food industry, which provides an extra-ordinary opportunity for the designing of customized and personalized nutrition for fruit and vegetable products. The most recent advancements on 3D food printing for fruits and vegetables and explore the prospect. Extrusion-based 3D printing is the most extensively used technique due to their several advantages **[18].**

- According to, Williams G.S et al, (2016) Fermentation and malting are age-long traditional food processes known to improve food value, functionality, and beneficial health constituents. Several studies have demonstrated the applicability of 3D printing to manufacture varieties of food constructs, especially cereal-based, from root and tubers, fruit and vegetables as well as milk and milk products, with potential for much more value-added products. This review discusses the extrusion-based 3D printing of foods and the major factors affecting the process development of successful edible 3D structures **[19].**

- Yan L et al, (2017) had shown that, differentiated from food extrusion cooking, extrusion-based food printing is a digitally- controlled extrusion process to build up complex 3D food products layer by layer. It is the most popular method in food printing, which provides an engineering solution for digitalized food design and nutrition control. The applied printing stages include Cartesian, Delta, Polar and Scar configurations, and three extrusion mechanisms, namely syringe, air pressure, and screw are utilized. A comparison between specialized food printers and 3D printers with food printing functions is reported in terms of food safety and system design complexity **[20].**
- According to, Dr. Ishack S. et al (2021), the global spread of COVID-19 has resulted in shortages of personal protective equipment (PPE) leaving frontline health workers unprotected and overwhelming the healthcare system. 3D printing is well suited to address shortages of masks, face shields, testing kits and ventilators. 3D technology has great potential to revolutionize healthcare through accessibility, affordably and personalization **[21].**

- According to, Derossi A. et al (2017), the morphological and microstructural properties were examined as affected by print speed and flow. Also, the changes in microbiological, antioxidant and sensorial attributes were monitored for 8 days at 5 °C. The appearance of 3D printed samples was more appreciated than the no-printed smoothie. Antioxidant capacity was constant during storage at 10.9 mg Trolox /100 g while total phenolic content reduced from 18.8 to 10.5 mg GAE/100 g. A concentration in bacteria of 4.28 Log CFU/g was observed after printing suggesting that 3D food printing will have to consider the sanitization of each part in contact with food before its application in restaurants and at industrial scale **[22].**

- According to, Lille M. et al (2020), the applicability of extrusion-based three-dimensional printing technology for food pastes made of protein, starch and fiber-rich materials was assessed, as a starting point in the development of healthy, customized snack products. The printability of starch-, cellulose nanofiber-, milk powder-, oat- and faba bean protein-based materials and their mixtures was evaluated by examining the ease and uniformity of extrusion as well as the precision and stability of the printed pattern. Extrusion-based 3D printing is a promising tool for producing healthy, structured foods, but further research is needed for optimising the mechanical properties of the printed materials **[23].**

- Bhandari B. et al (2017) reviewed that, software and robotics elements have been significantly improved our daily lives by teaching us much convenience and 3D printing is a typical example, for it is going to usher in a new era of localized manufacturing that is actually based on digital fabrication by layer-by-layer deposition in three-dimensional space **[24].**

- According to, Mosadegh B et al (2017), 3D printing is at the cross-roads of printer and materials engineering, non-invasive diagnostic imaging, computer-aided design, and structural heart intervention. Cardiovascular applications of this technology development include the use of patient-specific 3D models for medical teaching, exploration of valve and vessel function, surgical and catheter-based procedural planning, and early work in designing and refining the latest innovations in percutaneous structural devices **[25].**

- According to, Liu W et al (2013), 3D printing (3DP) is becoming a research and development focus in nano biomaterials as it can quickly and accurately fabricate any desired 3D tissue model only if its size is appropriate. The different material powders (with different dimensional scales) and the printing strategies are the most direct factors influencing 3DP quality. With the development of nanotechnologies, 3DP is adopted more frequently for its rapidness in fabrication and precision in geometry **[26].**

- According to, Cantinotti M. et al (2016) There are many successful cases that demonstrate the potential of the additive manufacturing in surgical planning in paediatric cases. In particular, most of the applications of 3D printing reported in the literature are related to the congenital heart disease **[27].**

- Mendonca D.A. et al observed that in (2016) A 3D model of a 2-year-old male child was intervein in order to plan the surgical treatment for his multi-structural craniosynostosis with a history of worsening cranial deformity. Other than the turri-brachycephalic skull, the child also had greatly raised intracranial pressure with papilledema and copper beaten appearance of the skull. Thorough preoperative planning enabled faster surgery and decreased aneshthesia time in a compromised patient **[28].**

- Gursel Alici, et al review that (2018) The ability to use Food Layered Manufacturing (FLM) to fabricate attractive food presentations and incorporate additives that can alter texture, nutrition, colour, and flavour have made it widely examined for combatting various issues in the food industry. FLM compatible for 3D printing structures and it's rheological analysis between two available breakfast spreads, vegemite and marmite **[29].**

- According to, Bhes B. et al (2017) Three-dimensional (3D) food printing is being broadly investigated in food industry recent years due to its multiple advantages such as customized food designs, personalized nutrition, simplifying supply chain, and broadening of the available food material. **[30]**

- According to, Karthik P et al, (2019) 3D printing is an innovation that promises to revolutionized food formulation and manufacturing processes. Preparing foods with customized sensory attributes from different ingredients and additives has always been a need. The competency that additive manufacturing offers has been among the key reasons for its success in food processing applications. A detailed note on the globalization of customized printed foods, personalized nutrition, and applications in food packaging to highlight the range of applications of 3D printing in the food industry is also given. Importantly, key challenges in 3D food printing, emphasizing the need for future research in this field are described **[31].**

- Zhang M. et al observed that (2020), 3D printing food technology is very well known in drug fields as well. Some application are involved in this: firstly, according to the individual patient this technology can print pills on demand, for every individual patient the dosage of medicine are suitable; secondly, it can provide a shape of each tablets and structure to control the release rate; thirdly, it can precisely control the distribution of cells, extracellular matrix and biomaterials to build organs or organ-on-a-chip for drug testing; finally, it could print loose porous pills to reduce swallowing difficulties, or be used to make transdermal microneedle patches to reduce pain of patients **[32].**

- According to, Martinez R. et al (2015) Drug delivery system is the control system that comprehensively regulates the distribution of drugs in the body in terms of time and space. 3D printing can adjust the shape and internal structure of the tablet by selecting materials, setting parameters and designing models. 3D printing technology can control the release rate and time because the printed tablets' release curve is linked to the shape of drugs. According to pharmacokinetics drug release rates are related to the geometry of the drug, and changing the geometry of the drug may affect drug release **[33].**

- According to, Agarwal A.K et al (2018) 3D printing also known as rapid prototyping and additive manufacturing. It is considered as a "revolution of a second industry"." With this rapidly emerging technology, CT or MR images are used for the creation of graspable objects from 3D reconstituted images. Patient-specific anatomical models can be, therefore, manufactured efficiently. The 3D printed patient-specific guides can also help in achieving accurate bony cuts, precise implant placement, and nice surgical results. Customized implants, casts, orthoses and prosthetics can be created to match an individual patient's anatomy. The 3D printing of individualized artificial cartilage scaffolds and 3D bioprinting are some other areas of growing interest **[34].**

- According to, Tappa K, et al (2018) Three-dimensional printing has significant potential as a fabrication method in creating scaffolds for tissue engineering. The applications of 3D printing in the field of regenerative medicine and tissue engineering are limited by the variety of biomaterials that can be used in this technology. The advantages of fabricating scaffolds using 3D printing are numerous, including the ability to create complex geometries, porosities, co-culture of multiple cells, and incorporate growth factors. Due to the nature of 3D printing methods, most of the tiles are combined with polymers to enhance their printability. Polymer-based biomaterials are 3D printed mostly using extrusion-based printing and have a broader range of applications in regenerative medicine **[35].**

- According to, Valjak F. et al (2021) Daily consumption of fruits/vegetables has a preventive effect against several chronic diseases, mainly because of their bioactive compounds (BACs) and potent antioxidant activity. Currently, a great potential in the field of food innovation can be achieved through 3D food printing (3DP). This is a technique for producing three-dimensional food products of any shape and dimension, with preferred flavours, and desired nutritional compositions. 3DP could be a promising tool to incorporate sensitive and easily degradable BACs and other functional ingredients into functional 3DP food products, making a great contribution to healthy food production **[36].**

- James S. et al review that (2022) there is a scope of potentials of 3D extrusion-based printing in resolving food processing challenges. The evolving trends of 3D food printing technologies, fundamentals of extrusion processes, food printer, and printing enhancement, (extrusion) food systems, algorithm development, and associated food rheological properties were discussed. The (extrusion) mechanism in 3D food printing involving some essentials for material flow and configuration, its uniqueness, suitability, and printability to food materials, (food material) types in the extrusion-based (3D food printing), together with essential food properties and their dynamics were also discussed **[37].**

- According to, Chunhua S. et al (2022) Different from reduction manufacturing and equal manufacturing, 3D printing is an additive manufacturing method, which transforms 3D model into 2D cross-section data to form entity layer by layer. This makes its processing not limited by complexity of the design model and number of the manufacturing products. It is very suitable for the medical field with high customization requirements. In fact, application of 3D printing technology in the medical field is particularly noticeable **[38].**

- According to, Jerry Y.H et al (2015) that target to revolutionize customized food fabrication by 3D printing (3DP). Different from robotics-based food manufacturing technologies designed to automate manual processes for mass production, 3D food printing integrates 3DP and digital gastronomy technique to manufacture food products with customization in shape, colour, flavor, texture and even nutrition. This introduces artistic capabilities to fine dining, and extend customization capabilities to industrial culinary sector. The selected prototypes are reviewed based on fabrication platforms and printing materials **[39].**

- According to, Zhang L. et al (2018) The demand for foods with specific functionality and nutrition is increasing. This study investigated the feasibility of 3D-printing to manufacture cereal-based food structures containing probiotics. Dough formulations with different water content, wheat flour type and amount of calcium caseinate were evaluated in terms of printability during fused deposition modelling. The composition of dough influenced its rheological properties and microstructure which were correlated to its printability **[40].**

- Severini C. et al observed that (2020) 3D printing clearly affects the microstructure generating bigger pores, less in number and like-round in shape. Also, we have observed that the positions of the pores are greatly driven by the printing movements. These features significantly affect the mechanical properties of 3D samples showing high hardness and cohesiveness **[41].**

- According to, Anukiruthika T.et al (2020) This study focuses on the development of fiber-enriched snacks from mushroom, an alternative food ingredient, using 3D food printing. The printability of the material supply was optimized considering varying levels of mushroom powder in combination with wheat flour (WF). The effect of variations in process variables such as printing speed and nozzle diameter (1.28 and 0.82 mm) was studied. It was possible to fabricate 3D printed constructs with good stability using the formulation containing 20% MP at 800 mm/min printing speed using a 1.28 mm diameter nozzle, 300 rpm extrusion motor speed at 4 bar pressure, with printing precision of 78.13% and extrusion rate of 0.383 g/min. Further, the conditions for post-processing of the 3D printed constructs were optimized **[42].**

- According to, Bhandari B. et al (2018) to establish a milk protien based 3D printed food simulant and investigated the effect of whey protein isolate concentration on the printing performance of milk protein concentrate (MPC). WPI and MPC powders at different ratios were prepared in paste. The rheological properties and water distribution of protein matrix prepared with different MPC/WPI ratios were characterized with a rheometer and LF-NMR, respectively. Moreover, the variations in the microstructure of printed objects were observed with a scanning electron microscope. The printed objects showed different appearance and physical properties; the printing fidelity was also evaluated by measuring the geometric accuracy of printed objects **[43].**

- According to, Liu L. et al (2021) 3D printing of high-liquid-oil-content food pastes is challenging. The objective of this study was to determine the effect of oil content on the printability of a model food paste. High-oil-content (up to 37%) pastes were prepared with water, canola oil, corn starch, and whey protein isolate (WPI). Effects of paste composition, paste conditioning, printing speed, extruding rate, and printed shape on printability were investigated. Viscosity and loss tangent values indicated that all the pastes were pseudoplastic fluids and exhibited predominantly elastic properties. Viscosity, storage modulus (G′) and loss modulus (G″) increased with the total mass of printed pastes **[44].**

- According to, Christensen A. et al (2017) The increased and accelerating utilization of 3D printing in medicine opens up questions regarding safety and efficacy in the use of medical models. It is an important shift towards point-of-care manufacturing for medical models in a hospital environment. This change, and the role of the radiologist as a central facilitator of these services, opens discussion about topics ranging from clinical uses to patient safety to regulatory implications **[45].**

- According to, Wilson A. et al (2021) The increasing demand for functional foods is associated with the need to deliver probiotics through novel food matrices. With a high-fiber and high-protein composite flour matrix was selected as the food vehicle. To improve their stability, four encapsulation techniques (spray drying, freeze drying, spray-freeze drying, and refractance window drying) were used for the production of probiotic encapsulates in oligosaccharide, whey protein, maltodextrin matrix. There is a huge need to develop customized/personalized products, the material supply was 3D printed using an in-house developed extrusion-based food 3D printer CARK (controlled additive-manufacturing robotic kit) **[46].**

- According to, Kim Y. et al (2021) Fruits have been used as potential food ingredients for the 3D printing of customized food for the elderly or infants. However, the tailing effect observed in the long paste extrusion of fruits results in low resolution during the extrusion process, which complicates their use. The correlation between the new experimental methods and the two actual printed separate objects was successfully verified using a 3D printing test **[47].**

- Simon J.A et al, observed that (2021) Use of plant-protein for material extrusion 3D printing presents an exciting opportunity to expand current material and additive manufacturing applications. Plant protein-based materials possess attractive thermomechanical properties, which make them prospective sources for use in 3D printing. This review provides insights into the current state of protein-based material properties, specifically in the context of material extrusion 3D printing applications **[48].**
- According to, Jiang H. et al (2021) The effects of material composition on the quality of 3D-printed food using wheat starch, flour and whole meal were explored. Wheat flour had the worst printable capacity as it gets stuck easily to the wall of the printer. Starch-protein complexes appeared in the samples of wheat flour and whole meal. whole meal with higher protein, fat and fiber content was better for food 3D printing than wheat starch and flour **[49].**

- According to, Zhang M. et al (2021) Synergistic calcium-chloride and microwave heating treatment and 3D printability was applied to improve the rheological properties and printability of a model buckwheat starch-high-methoxy pectin (BP) gel system **[50].**
- According to, Holland S. et al (2018) Additive Manufacturing of 3D printing techniques have been previously applied to food materials with direct consumption in mind, as opposed to creating structural ingredients. First, semi-crystalline cellulose was mechanically treated by ball milling to render an amorphous powder, which has been characterised **[51].**

- According to, Derossi A. et al (2018) Printed snacks satisfactorily matched the designed structure. A 70% flow resulted in irregular structures with oversized porosity. By increasing flow level, a higher amount of deposited material produced an increase of total volume, weight and side-length of the samples while the fraction of porosity reduced **[52].**

- According to, Sicard J. et al (2019) 3D Printing or additive manufacturing (AM) now provides enormous freedom to design, manufacture and innovate in various domains, even in foodstuffs development **[53].**

- According to, Lipton I. et al (2017) Millions of Americans suffer from diseases and conditions that require careful control of their diet as part of treatment. The current solution is to have each person customize their own food choices. 3D printing is an ideal family of technologies for enabling such mass customization of food. Current efforts in 3D printing food are focused on improving the artistic quality of food in the short term and consumer health in the long term **[54].**

- According to, Daffner K. et al (2021) The current interest in manufacturing of individualized food via 3D-printing has identified a need for more information on the understanding and formulation of potential ingredients. The pH−temperature-route of acid gelation was shown to be a suitable mechanism for extrusion-based 3D-printing applications of skim milk retentates (8–12% protein, w/w), obtained by micro filteration. pH was adjusted to 4.8–5.4 by adding citric acid at 2 °C. Sol−gel transition was triggered either by linear temperature ramps (1 K/min) or with temperature–time profiles (ΔT = 15 K, 30 K/min) comparable to 3D-printing but without superimposed flow **[55].**

- Condoor K. et al, reviewed that (2018) the recent developments in the application of 3D printing to medicine. The topic is introduced with a brief explanation as to how and why 3D is changing practice, teaching, and research in medicine. Then, taking recent examples of progress in the field, we illustrate the current state of the art. This article concludes by evaluating the current limitations of 3D printing for medical applications and suggesting where further progress is likely to be made **[56].**

- According to, Jayaprakash S. et al (2020) 3D food printing is an emerging food technology innovation that enables the personalization and on-demand production of edible products. While its academic and industrial relevance has increased over the past decade, the functional value of the technology remains largely unrealized on a commercial scale. This study aimed at updating the business outlook of 3D food printing so as to help entrepreneurs and researchers in the field to channel their research and development activities **[57].**

- According to, Chitrakar B. et al (2020) Three-dimensional (3D) food printing technology combines 3D printing and food manufacturing. Rapidly increasing number of publications on various aspects of 3D food printing indicate the importance of this technology to food industry. It’s analyzes the functions of internal structures used or developed during 3D printing (infill structure and infill density) and their effects on texture properties of 3D printed food **[58].**

- According to, Bommel K.V. et al (2021) The current pandemic has affected the food system in many ways: significant changes in dietary habits and in the health status of people; the food chain is broken, which has an effect on food security (including making it difficult to find or to buy fresh food at affordable prices); unemployment or underemployment. To mitigate all these issues, the implementation of innovative technologies urges. We have mapped the scientific studies and online information on 3D food printing (3DFP) about the effects of 3DFP on the food system and people’s health when adopted in food industry, restaurants, hospitals, schools, offices, homes, etc **[59].**

- According to, Sharma S. et al (2022) 3-D printing is a neoteric technology that can make existing food value chains client-desirable and sustainable by providing on-demand food production, enabling automated food personalisation, and minimising food wastage **[60].**

- According to, Yuan C. et al (2022) 3-D printing is a neoteric technology that can make existing food value chains client-desirable and sustainable by providing on-demand food production, enabling automated food personalisation, and minimising food wastage **[61].**

- According to, Mathur M. et al (2015) 3D model of an aortic root with anomalous coronaries from a cardiac computed tomography angiography image using a Siemens Sensation 64-slice scanner and printed it on a Stratasys Dimension Elite station using acrylonitrile butadiene styrene plastic. Since the contrast-endovascular interface is nonuniform, variability in extraction results in holes in the model. Image processing can fix these holes and offset fragility; however, this diverts us away from true anatomy **[62].**

- According to, Cakmak H. et al (2020) 3D food printing technology has a great potential to reduce food waste by making use of discarded food parts such as meat scraps, and damaged fruits and vegetables. However, there are some obstacles regarding the building of a 3D structure, as well as retaining the designed geometry in the post-deposition period. The composition and properties of food materials and processing parameters are effective on the characteristics of the final 3D printed foods **[63].**

- According to, Lee T.C. et al (2019) Digital fabrication technology, also referred to as Three-Dimensional Technology or additive manufacturing, creates physical objects from a geometrical representation by successive addition of materials. 3D printing technology is a fast-emerging technology. Nowadays, 3D Printing is widely used in the world. 3D printing technology increasingly used for the mass customization, production of any types of open source designs in the field of agriculture, in healthcare, automotive industry, locomotive industry and aviation industries **[64].**

- According to, Khaled S.A. et al (2014) Three-dimensional (3D) printing was used as a novel medicine formulation technique for production of viable tablets capable of satisfying regulatory tests and matching the release of standard commercial tablets. Hydroxypropyl-methylcellulose (HPMC 2208) , poly (acrylic acid) (PAA) (Carbopol 974P NF) were used as a hydrophilic matrix for a sustained release layer **[65].**

- According to, Aita E.L. et al (2020) The implementation of tailor-made dosage forms is currently one of the biggest challenges in the health sector. Over the last years, different approaches have been introduced to provide an individual and precise dispensing of the appropriate dose of an active pharmaceutical ingredient (API) [**66**].

- According to, Saviano M. et al (2021) the patient-centred approach of precision medicine innovative floating drug delivery systems have been developed through the use of alginate matrix and fully characterized. Particularly, to exploit the ionotropic gelation of alginate, a customized coaxial extruder for Semi-solid Extrusion 3D printing, has been used for the simultaneous dispensing of ink gel and crosslinking gel **[67].**

- According to, Nagata N. et al (2019) The production of three-dimensional (3D)-printed drugs holds promise for future personalized medicine. Here, we prepared tablets containing naftopidil as a model drug using a semisolid extrusion-type 3D bioprinter applicable for tissue engineering **[68].**

- According to, Hull C. et al (2017) 3D printing – a mechanical process whereby solid objects are created by 'printing' successive layers of material to replicate a shape modelled in a computer – has been adopted in numerous industries. The key properties of 'additive manufacture' (AM), as opposed to subtractive manufacture (whereby 3D objects are created by starting cutting, carving or drilling), were speed, precision, and the ability to make highly customised, one-off models **[69].**

- According to, Zang P. et al (2022) Three-Dimensional printing is very important for spaceflight to providing digital food engineering method for a long-time manned spaceflight. It is the most suitable technique for manned spaceflight. Extrusion based 3D printing distribute most of the energy and proper nutritional requirements of astronauts during a long-term spaceflight. It's also providing fruits, vegetables and meat products materials by utilising this method **[70].**

- According to, Maguire A. et al (2022) For sustainable, flexible and customizable manufacturing scheme additive manufacturing gained popularity. With the help of techniques of additive manufacturing directly ink writing has emerged as the most interesting and versatile 3D printing technique for the broadest range of materials.**[71].**

- According to, Tutika R. et al (2022) Soft, elastically deformable composites with liquid metal (LM) droplets can enable new generations of soft electronics, robotics, and reconfigurable structures. This enables filaments, films, and 3D structures with unique LM microstructures that are generated on demand and locked in during printing **[72].**

- According to, Yeong W. et al (2021) Three-dimensional techniques for advanced electronic components and devices includes inductors, parallel plate capacitors, displays, photovoltaics etc. Such components involve in multi-layer and multi-material printing. **[73].**

- According to, William J. et al (2017)_Now a days, hybrid 3D printing technology is newly formed method to combine direct ink writing of conductive and dielectric materials. It is the main surface mount of electronic components within an integrated additive manufacturing platform **[74].**

- According to, Tran T. et al (2019) 3D printing technology for electronics additive manufacturing industrial sector has grown rapidly in the last few years. Day by day there increasing a demand for different type of nanoparticle inks. It is critical to gain a deep understanding of the metallic nanoparticle inks used in 3D printed electronics. It is the main material mechanical part of this printed patterns **[75].**

DISCUSSION

3D, CAD model starts the direct production of 3D printing technology. Production time from design to the final product is quite low. 3D Printing develops the product very fast as compared to conventional methods. Production time reduced from months to days with the help of 3D- Printing. With the 3D-Printing materials production are produced at much faster rates. Development costs of product reduced enormously. The cost of production run of this procedure is quite low. Prototype developed with this technique is tested under various circumstances. It sells on various online sites and gets customer response for the betterment of the product. It also provision the sharing of knowledge and modification of design with the help of experts from different parts of the globe. As the process is additive in nature the wastage of material is very low. Hollow part and holes are directly produced in 3D Printing Technology. It saves the materials as well as machining cost also. Manufacturing of complicated design and contour shapes are easy with 3D Printing. Small batches and customized products are economical with this production method as compared to traditional methods. Replica can be created very easily using 3D technology raises the issue over intellectual property rights. That may be edited and modified and used again. Components manufactured by 3D-Printing is limited by sizes now a day. The practicality of large components is very less. In recent time a large number of smart materials are present in worldwide. Many of which are not suitable for 3D-printing. The use of this smart material is increased day by day. The initial investment cost of 3D-Printer is very high. It is not feasible for small or average householders. Different printers are required for a different types of materials and different types of components. Manufacturing of colour components is also costlier than monochrome objects.

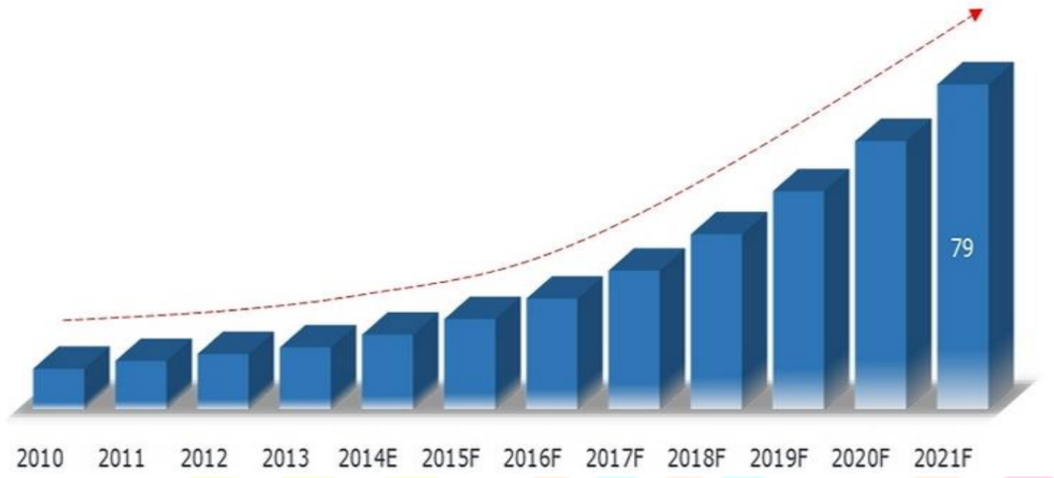


Figure 2: Growth rate of 3D printing technology in food industry in India

CONCLUSION

3D- Printing reshapes and revolutionized the world. The manufacturing of custom implants are very easy and cost effective with 3D-Printing. It is very fast and reliable method in the field of medical science. The costs of tailor- made parts are also less as compared to other methods. This technology is also prove- beneficial in some critical condition of patient. The manufacturing of scaffolds tissue and bone should be considered as promising with this technology. 3D-Printing provide extensive support in medical application. It is also exploring new market to help humanity.

In the field of medical oriented Three-Dimensional Technology has been made great progress. The manufacturing of organ models permanently implant has become more progressive. Although the direct printing of tissues and organs is still in the initial stages, domestic and international researchers using printed tissue and organs have begun to study the printing of vessels. Medical biomaterials used in 3D printing consist of metals, polymers, and ceramics, with multiple materials usually being integrated in order to achieve complex functions in the printed components. Although 3D printing has already been realized in clinical applications, 3D printing technology is still limited in terms of materials and in the construction of ECM. Much work remains to be done before printed bioactive tissues and organs can truly be applied in the clinic.

FUTURE ASPECT OF THE STUDY

The future prospect of 3D printing Technology successfully integrate with tissue engineering. Future work includes developing new equipment to guarantee the high porosity and dimensional precision of scaffolds; studying high-performance materials for various medical-oriented 3D printing techniques; creating unified standards for 3D Printed scaffolds, strengthening market supervision in order to optimize implants for clinical use; and establishing a 3D printing platform in order to enhance communication among hospitals, companies, and research institutes. These advancements will further promote the development of 3D printed tissue Engineering Scaffolds.

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