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Review on Plant Based Meat (The Future Option)

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Introduction:-

As the world population expands and countries become wealthier, the already high global demand for animal protein continues to increase. To meet this growing demand, the food system requires large-scale, industrialized methods of raising farm animals for food. Although modern food production is vastly more efficient than 100 years ago, industrialized animal agriculture still suffers from both market and production in efficiencies (1). If animals are thought of as biofactories for transforming plant matter into animal protein, animals are processing plant nutrients into meat at only 3–11% efficiency (2). Any industrial process with such high rates of inefficiencies is ripe for disruption. Processing plant ingredients into meat analogues without using animals can be done more efficiently. For example, producing a plant-based burger instead of a beef burger cuts greenhouse gas emissions by 30–90%, reduces water use by 72– 98%, mitigates 51–94% of potential water pollution, and uses 47– 99% less land (3). The term "plant-based meat" is used to refer to plant-based products designed to replace animal meat. This includes products that replicate the taste and texture of meat, as well as products made from plants (such as jackfruit, seitan, tofu, and tempeh) that serve as functional meat replacements. Although fungi and algae are not biologically classified as plants, fungi- and algae-based products are included in this definition of plant- based meat. Global growth in the plant-based meat industry has exploded over the past few years. Hundreds of plant-based meat startups have been launched in countries as varied as Brazil, China, India, Israel, the Netherlands, and the United States. Many established food and agribusiness companies are launching plant-based product lines, and hundreds of millions of investment dollars are pouring into the plant-based meat space. Plant-based meat products have started popping up on global menus in the United Kingdom, Europe, Israel, Canada, and the United States in restaurant chains such as McDonald's, Burger King, Starbucks, Qdoba, and Dunkin' Donuts. The NPD Group reports that in the United States foodservice sales of plant-based meat grew 37% in 2019 (4). Plant-based burgers now have a 3.4% market share in the fast food sector (5). U.S. retail sales of plant-based meat were US$939 million in 2019, growing 18% year-over-year— more than six times faster than animal meat and accounting for 2% of retail packaged meat sales (6). Similar trends are occurring in other regions of the world, with the European Union seeing a 15% compound annual growth rate (CAGR) for alternative proteins (7) and China experiencing about 14% year-over-year growth in its domestic plant-based meat industry (8). Plant-based foods appeal to a wide variety of consumers for many reasons. Personal health, taste, environmental sustainability, and animal welfare are primary motivators for eating more plant based foods (9). People using vegetarian (plant based) diets can be classified into differentsubgroups. Vegans do not consume any animal products; therefore they avoid suchtypes of products in their daily lives and this approach is not limited to their meals. Lacto vegetarians also consume milk and dairy products. Semi-vegetarians mostly use aa plant-based diet, which can, however, be supplemented sparingly by consumption poultry and fish. Flexitarians are similar to the above subgroup; they mostly eat vegetables and fruits, but does not have to give up meat and fish. Pesco-vegetarians are considered one of the most tolerant users of a plant-based diet, except for additives of plant origin, their diet also includes milk, dairy products, eggs and fish [10,11,12]

History and Approach:-

Plant-based mushroom (PBM) meat products include flavor, texture and/or nutritional value aspects of meat but differ in composition; namely, they are made from non-animal sources materials. Based on development time and technical complexity, products may be PBM they are divided into two flexible categories: traditional and new (i.e., next generation)(13). Traditional meat analogues were developed thousands of years ago in Asia and include relatively simple derivatives from soybeans (ie, tofu, tempeh) or wheat (ie, seitan)(13). Compared, the new PBMs are characterized by designing and marketing the products as nearly equivalent substitutes for ABM with respect to taste, texture and nutrition. Product categories can too they exist between traditional and novel as they may fulfill some but not all of the above criteria. The distribution map of global companies and brands developing new PBMs can be can be found in Fig. 1. Production of PBM typically involves three steps(15): (i)

Isolation of the protein and functionalization – target plant proteins are extracted from plants, some of which are subjected to hydrolysis to improve their functions such as solubility and cross-linking capacity; (ii) Formulation – Vegetable proteins are mixed with ingredients to develop them meat textures such as food adhesives, vegetable fat and flour. Nutrients are added to match or they exceed the nutritional profile of meat. (iii) Processing – Mixture of vegetable proteins and others ingredients undergo protein conversion processes (e.g. stretching, kneading, cutting, pressing, folding, extruding, etc.) to create a meat-like texture. Innovative technologies are used for this to improve the organoleptic properties of PBM include shear cell technology, mycelium cultivation, 3D printing and recombinant protein additives(16,17). CBM, also referred to as v in vitro meat, lab-grown meat or meat grown in culture is meat produced by culturing cells as opposed to to farm animals. CBM technology is based on advances in stem cell biology (e.gpluripotent stem cells) and initially tissue engineering (eg in vitro skeletal muscle grafts). intended for medical applications. CBM production involves four main components: (1) isolation and cultivation of muscle and fat cells, (2) formulation of xeno-free culture medium, (3) scaffold bioreactor development and (4) design; the details of which are described at length elsewhere (14. Interestingly, the concept of CBM can be traced back to 1930 when Frederick Smith, The British Secretary of State for India envisioned the genesis of "self-reproducing steaks" through an excerpt from his collection of essays The World in 2030 AD which reads: "It will no longer be In order to eat his steak, one must go to the extravagant lengths of raising a bull. From one 'parent' pairs of selected tenderness, it will be possible to grow a steak as large and juicy asmay be required (18). While CBM has yet to be commercialized in 2020, remarkable progress is being made has taken place over the past few decades. Key milestones include the first CBM patent by Willem van Eelen in 1999 (19), the first peer-reviewed research on cultured fish funded NASA in 2002(20) and the first cultured beef burger debuted by Maastricht University in 2013. Today there are dozens of start-ups around the world trying to bring CBM products to marketCompanies were included as listed in the Good Food Institute alternative protein company database (August 2020)

The first generation of PBMA (PBMA 1.0):-

With the motivations of religious beliefs, animal rights, health benefits, and personal preferences, the number of vegetarians has dramatically increased, especially in developed Western countries (21). Therefore, with the rise of modern PBMA, TVP is among the most popular options for consumers (22,23). Initially TVP was a registered trademark, but it is now used to define special kind of products. These special products are derived from edible vegetable protein mixed with minor ingredients or chemicals (22,23). This fusion is then used to create similar structural and textural properties as consumable meats (22,23). Although soybeans are currently the largest global source of protein alternatives, other vegetable protein, such as glandless cottonseed flour, canola or rape seed concentrates, and defatted peanut flour, can be used as raw materials for PBMA as well (22,23). TVP products with similar textures and tastes to meat can be created by several special technologies, with extrusion being the most widely used method (24,25)

Techniques for creating meat-like appearance and flavor:-

Color is often the first element you notice about food products; is therefore a major contributor on taste perception and overall acceptance of the product by consumers (26). Usually, unheated fresh meat has a red color that turns brown after cooking. Meat analogues should strive to obtain a similar appearance to real meat by imitating the original color as well as color resulting color changes during cooking. Most vegetable protein components, such as gluten and soy, are originally yellow or beige in nature (27). In addition, they can reduce sugars added as browning agents because they are able to form brown substances during cooking through the Maillard reaction with amine groups in the protein (28). In a new generation PBMA, the red color of the raw materials was obtained by adding beets juice/powder or soy leghemoglobin (29). Thermal stability and pH sensitivity of the dye substances are of great importance for their successful application in PBMA (27). Thermally unstable dyes deteriorate during the cooking process and can cause unacceptable color appearance. For the coloring effect to be optimal, the pH range should be a the given dye should correspond to the dye of the meat analogue. Dyes can be either mixed with protein products prior to the structuring process or may be integrated semi-structured materials of vegetable origin during the structuring process (27) Food flavor is another influential element that plays a significant role in product acceptance (30). Process The creation of flavor is considerably more complex than the creation of color and flavoring can be divided into volatile and non-volatile compounds, which are related to smell and taste, respectively. Meat has an umami flavor that comes mainly from presence monosodium glutamate and inosine monophosphate, as well as various small organic acids (27). In addition, raw meat requires only one heat treatment to be consumed; however, PBMArequires much more complex treatment. High heat and pressure during the structuring process and cooking PBMA involves additional heat treatments. Our taste analysis compounds showed a significant difference between the first and new beef burgers generation of plant-based hamburgers (dates not published). Although it is difficult, it happenedsome progress in the process of mimicking the taste of PBMA. It was proved, that adding flavorings such as spices and salt to plant food mixtures as before and after the extrusion process, it can help create tasty and fragrant end products (27). Some of the ingredients that helped create the impression of aromatic meat in PBMA products include the vitamin thiamine, amino acids, and reducing sugars (31). in addition Chicken and beef-like flavors were made from proteins hydrolyzed by soybeansspecific reaction conditions (32). Nonetheless, additional research is required to further develop meat-like aromas in PBMA products.

The selection of plant-protein sources:-

The organization of the PBMA structure is dependent on the properties of the protein, such as the ability retain liquids, as well as its gelling and solubilizing abilities (33). In addition, different types of protein can ultimately cause altered appearance, taste, nutrition and health effects product. Thus, choosing an appropriate protein source remains one of the key aspects for PBMA Production. A wide variety of plant proteins are currently used in industry production of meat analogues, but soy and peas are the primary source due to low cost and possessing some flesh-like properties (27). Some waste biomass represents potential protein source for PBMA due to the high levels of protein present. This method is highly desirable because it helps reduce the amount of waste products and helps reduce the amount of resources needed for food production. In addition, commercialization of edible insects and insect-based meat alternatives has begun in Western countries, along with the gradual adoption number of consumers (34).According to summary data, proteins obtained from legumes such as chickpeas and soybeans are ideal for PBMA production due to their functionality properties, while insect proteins and zein are among the most cost-effective options (35)

Nutrients:-

A key question in discussions about replacing animal foods with plant substitutes is whether plant substitutes can adequately meet nutritional requirements. Like omnivores, humans tend to meet some nutrients more easily from plant sources, while other nutrient requirements they are generally better satisfied by eating animal foods. For example, our vitamin C and Magnesium needs are much more easily met from plant foods than from animal foods. In addition, plant-based foods are often higher in folate, manganese, thiamin, potassium, and vitamin E (36). Plant foods also provide a wide variety of phytochemicals that are important regulatory role in human health (37). Key plant proteins used in PBM formulations (eg, pea, soy, wheat) provide total protein content at levels comparable to ABM. However, supplementation of multiple plant proteins is generally necessary to ensure a balanced amino acid profile. For example, legumes (with low sulfur content amino acids, high in lysine) and cereals (low in lysine, high in sulphur-containing amino acids) proteins are beneficial supplements. Factors that have been identified in plant proteins that can reductions in the bioavailability of nutrients after ingestion include: structures resistant to proteolysis, protein conformation and antinutrients (eg tannins, phytates, lectins). Certain processing techniques (e.g. soaking, heating, sprouting) have been proven to increase digestibility. Nutrition also differs between traditional and new PBM products. For example, tofu (traditional PBM) and Impossible™ (new PBM) share certain advantages over ABM, such as containing fiber and minerals and at the same time lack of cholesterol. However, benefits specific to tofu contain fewer calories, less fat and sodium-free and Impossible™ - specific benefits include higher protein and vitamin B12 content (Fig. 2). Concerns were expressed about inclusion of LegH in PBM with reference to correlations between heme iron intake and increased risk diabetes. Furthermore, they indicate the findings of extensive experimental data in vitro and in vivo that plant compounds can antagonize some of the harmful effects of compounds found in cooked red meat (e.g. heterocyclic amines, nitros compounds, malondialdehyde, advanced glycation end products, etc.) (38,39,40,41,42,43)and tofu were obtained from the Food Data Central database (FDC ID: 174036, 167902, 171116, 388713) and Impossible™ and Quorn™ data were obtained from company websites. Content is quantified by the percent of recommended daily intake as determined by the FDA

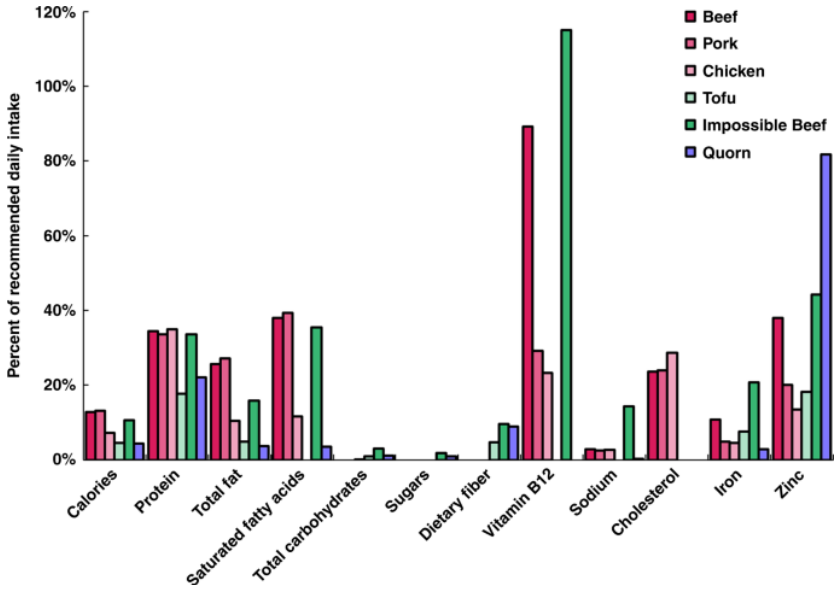


Fig. 2; Nutritional value of ABM (beef, pork, and chicken), traditional PBM (tofu), novel PBM (Impossible™ Beef), and mycoprotein (Quorn™) per 100 g wet weight, raw

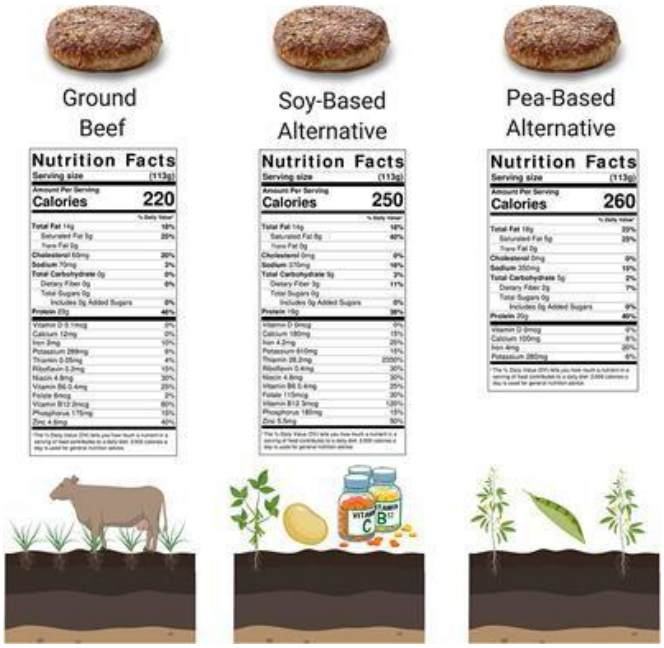
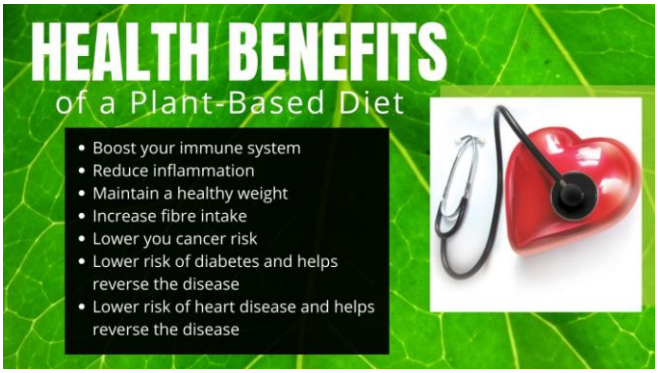


Fig 3: Plant based meat Nutrients

Benefits of the Plant-Based Diet :-

Research shows that the most important benefits of a vegetarian diet can be associated with positive health factors [44,45,46,47,48]. The conclusions of a representative survey conducted in The US suggests that the prevalence, patterns, and other associated factors of vegetarianism and veganism diets, are more prominent among Americans when these dietary changes protect their health [49], [50] surveyed 100 people in the US about what motivates their health beliefs to change their lifestyle and to change their eating habits. Nutrientintake wasassessed based on "reference dietary intake". Health turned out to be the most important (47%) a reason to change the diet. The second most important reason for switching to a plant-based diet may be related to well-being and satisfaction. Compared to these, connecting to animal welfare and environmental sustainability were factors less frequently preferred reported [51,46,52]. Jabs and Devine [53] tracked the preferences of vegetarians related to animal health and welfare. They conducted face-to-face interviews with 19 vegetarians. They divided vegetarians into two categories. The main motivation for health-oriented vegetarians it is associated with the health benefits of diet and through them the avoidance of health risks. The key considerations of ethical vegetarians are moral and sustaining animal welfare.[54] conducted a nationally representative survey and asked Dutch people consumers over the age of 18 in their research entitled “National Food Consumption Survey". It turned out that, in addition to health and social factors, vegetarians are consumers had a positive relationship with the importance of information about products, specialized stores, news, and organic products. A detailed analysis of the factors that mostly support a plant-based diet are below. The analysis is based on the classification given by Corrin and Papadopoulos [55], Rosenfeld [56] and Ruby [57].



Health Beneficial Factors:-

A plant-based diet can reduce body fat and thus the degree of obesity [58,59]. It should be added, however, that if the total body weight is also lower, it may have a lower total fat mass, but the degree of adiposity is not necessarily lower. This was stated by a research study conducted Berkow and Barnard [60] who evaluated the body weight of vegetarians and non-vegetarians. Evidence suggests that vegetarian men weighed 4.6–12.6 kg less and vegetarian women weighed 2.9–10.6 kg less than their non-vegetarian peers. By using a well builtdiet, cardiovascular diseases that arise mainly as a result of obesity or leading risk factors to obesity, can be prevented [61,62]. A reduced intake of saturated fat is also considered important health benefits of a vegetarian diet [63,64,65]. By conducting experiments on humans, researchers demonstrated that subjects consuming a plant-based diet had higher levels of serum albumin beneficial effect on their balanced nutritional status than those using a mixed diet [66]. The amount of important nutritional components such as magnesium, potassium, folic acid, fiber, of antioxidants including vitamins C and E and phytochemicals is higher in people with a plant-based diet [58,67,68]. The absorption of plant-based iron can be facilitated with the right amount of vitamins [69]. A plant-based diet is able to reduce risk factors leading to development of diseases, which is an extraordinary health benefit [70]. There were already fewer people found to be dying of heart disease and incidence of type 2 diabetes, dementia, gallstones, kidney disease, rheumatoid arthritis and various types of allergies decreased [71,64,72].

In addition to the above, it should be emphasized that a number of nutritional recommendations emphasize risk factors of consumption of red and processed meat in development above all cardiovascular diseases. However, it has been suggested by a growing body of research study that only excessive meat consumption can be considered a real risk factor [73,74,75]. Even so, the overall negative view of meat consumption is supported the opinion of those who have chosen a plant-based diet, which is considered healthier [73,74,75]. Most vegetarians have lower cholesterol and blood pressure end of normal range [64,76,65,77,72,78,79,80]. Reducing meat consumption a favoring a plant-based diet can be effective methods to reduce the likelihoodthe development of some (not all) types of cancer. According to the International Agency for Research on cancer (IARC), red meat is “probably carcinogenic to humans” while processed meat products are “carcinogenic to people” [61,81,82,83,84].

Obstacles to eating a plant-based diet:-

The enjoyment of eating meat and the immense difficulty of giving it up are indicated surveys are the biggest barrier to switching to a plant-based diet [64,85]. Compared with factors associated with health and comfort were identified be less important. Similar to the previous section, the following analysis was based on classification was done by Corrin and Papadopoulos and Ruby.

Some Barriers Of Plant Meat:-

1.Excessive commitment to eating meat and the difficulty in abandoning it.
2. Risk of low protein intake.
3. Low intake of micronutrients for example, vitamin B12 and vitamin D, as well as that of riboflavin, iron, calcium and zinc.
4. The preparation of meals is too complicated.
5. It easily becomes boring and tasteless.
6. The range of relevant and available information is very limited.
7. Vegetarians are more neurotic and depressed than omnivores, causing them poorer mental health.
8. Daily meals and raw materials are too costly to obtain

Negative Effect on Mental Health:-

Baines et al. [86] compared the health status of vegetarian and omnivorous young Australian women. Their findings indicate that vegetarians experienced poorer mental health at their own discretion. Forestell and Nezlek [87] also reached a similar conclusion; according to their results, people following a plant-based diet are more open to novelties; however, they are also more prone to depression. It should be emphasized, however, that scientific views on the impact of plant-based nutrition on mental health are divided. In addition to the negative effects presented above, several researchers believe that, in a number of cases, plant-based nutrition can also have a positive effect on the individual’s mood [88,89,90].

Economic aspects and future trends:-

An important reason for the increased acceptance of plant protein is their low cost and fibrous texture. The major challenging task for the food engineers however is to develop the fibrous three-dimensional structure from these plant proteins while maintaining their nutritional properties so as to provide these alternate meat products the same meaty texture. Texturized wheat gluten is commercially available in several forms differing in size, shape, density, colour, and texture. The popularity of texturized wheat gluten is rapidly increasing due to abundant production of wheat throughout the globe. The researchers are trying to develop wheat varieties that have a minimum amount of gluten while maintaining its technological properties. Genetic engineering can enhance the quality of plant-based food products through the silencing of genes. New plant-based meat analogues should taste, feel and smell better, or at least as good as animal meat according to the perceptions of the majority of consumers. It is very probable that flavour (umami flavour associated with meat) and texture (fibre like as in meat products) are the most important keys to success, and at the same time, the biggest challenges for the researchers. It can be concluded that there is a demand as well as bright future of such products in the market keeping aside a few constrains which need solution but with the heap of opportunities.

Conclusion:-

Based on this systematic review of randomized clinical trials, there is an overall robust support for beneficial effects of a plant-based diet on metabolic measures in health and disease. However, the evidence for cognitive and mental effects of a plant-based diet is still inconclusive. Also, it is not clear whether putative effects are due to the diet per se, certain nutrients of the diet (or the avoidance of certain animal-based nutrients) or other factors associated with vegetarian/vegan diets. Evolving concepts argue that emotional distress and mental illnesses are linked to the role of microbiota in neurological function and can be potentially treated via microbial intervention strategies.

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