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Designing A Future Food, Plant Based Protein Blend to Promote Sustainable Nutrition

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Abstract:
Background : Sustainable nutrition is environment friendly which promotes individuals' health and wellbeing that has a low environmental pressure . It's easily accessible, affordable, safe, and equitable that are culturally acceptable hence it is imperative to design recipes or blends that provides an optimal source of nutrition through plant based diets that will eventually reduce the dependency on animal source . Aim and Objectives: An attempt to formulate plant based blend to source vital nutrients like protein , iron , essential fats for those adopting to plant based diets . To design recipe that provides an optimal amount of nutrients that helps to promote sustainable diets .Materials & Methods : Ingredients to formulate plant based blend involved sprouted peas ,niger seed ,low glycaemic index potato & pumpkin seed. The total nutritive value of 120ml formula provided 106kcal ,5.5g protein, 9.5g carbohydrate , 4.4g fat and 2.1mg iron. Sprouted peas and low glycaemic index potatoes were leached , cooked and blended. Results: The end product can be used as a ready to use soups ,tube feed blend, as dosa and base for curries. The formula provides 20.7% of protein from energy with 10% of Recommended Dietary Allowance from 120ml with a potent source of iron, protein, essential fats and other micro nutrients vital while following plant based diet. The use of low glycaemic index potato which is included in less proportion of 10g in 120 ml of blend to prevent glucose spike. The overall cost of the product was 11 rupees (INR) for 120ml of blend. Conclusion: Plant based formula designed to optimize nutrient requirement as a source of vital nutrients such as protein , iron and essential fat through sustainable ingredients with an affordable cost which can be included as a tube feed blend or convert the same as pancake that can be a snack choice for those depending on plant based diet.

Keywords: sustainable diets , plant based diet, protein blend, low glycaemic Index potato, niger seed

Introduction :
Sustainable nutrition is focused on an optimal and health-promoting diet which is culturally acceptable, easily accessible, and eco-friendly by reducing environmental costs for present and future generation of our country. Promoting organic food and reducing meat ingestion is one of the strategies that fits into environmentally sustainable food consumption (Magdalena Gibas-Dorna et al., 2024) .India consists of the largest number of vegetarians compared to other countries worldwide, with ~30% of the population being lacto-vegetarian (S Agarwal et al., 2014) . The focus on plant based diet has been shifted due to the present societal concerns related to urbanization that has burdened our environment such as land, water and natural sources (Lundqvist et al., 2007). Exploring plant based options will reduce the consumption of animal sources that will not only lead to counterbalancing of extensive animal farming (Van Mierlo, Rohmer, & Gerdessen, 2017) rather provide us options to design more formulation to address our current trends that will help us to overcome health challenges involved due to obesity and malnutrition. Our present practices involved in production of food and our practices are closely associated with high prevalence of Non-Communicable Diseases (NCD) and an extensive damage to our environment (Poore, et al., 2018). Many believe that a plant-based diet suppose to be considered as healthier than an animal-based diet that has been contributing to healthy eating behaviour but continue to anticipate deficiencies in both population hence we need to screen for deficiencies to fortify foods with vital nutrients such as Vitamin D , Calcium and Zinc(Possidonio et., 2021). Due to pressing concerns involving environment, health and ethical reasons for not harming animals, the plant-based food sector is rapidly expanding to meet consumer demand(Crosser et al., 2020).
The food industry should identify an appropriate combination of ingredients involved in plant-based foods to fill up the gap in nutrient deficiencies with an ideal nutrient profile that addresses commonly observed deficit to mimic the animal derived products that improves digestibility, and bioavailability of the product (David Julian et al., 2021). In the case of plant proteins, it is important to ensure that they are able to provide the full complement of essential amino acids and that they are digestible (Loveday et al., 2019).
Research data reveals that plant based diets are cost-effective with low risk of interventions which may lower body mass index, hypertension , HbA_{1C}, and cholesterol levels, and may also reduce the number of medications that are used to treat many chronic diseases (Philip J Tuso et., 2013). A healthy plant-based diet promotes to maximize the intake of nutrient-dense plant foods while minimizing foods that are processed and of animal origin. It mainly focuses on improving the

intake of vegetables, fruits, lentils ,peas ,beans, peas, seeds, and nuts (in smaller proportion) and is generally low in fat (Philip J Tuso et., 2013). A plant-based product may also contain excess sugar, fat and salt and can be classified as ultra-processed food(M.Ohlau et al.,2022)

The following distinction of these diets will help us understand by definition to know what it includes or excludes:

Vegan: This excludes all animal origin products including meat, honey, seafood, poultry, eggs, and dairy. It does not promote the exclusion of processed foods , neither it discourages the consumption unhealthy fat or refined sugar.

Raw food, vegan: This excludes all animal origin products including meat, honey, seafood, poultry, eggs, and dairy and foods cooked at temperatures greater than 118°F.

Lacto-vegetarian: Excludes eggs, meat, seafood, and poultry and includes milk products.

Ovo-vegetarian: Excludes meat, seafood, poultry, and dairy products and includes eggs.

Lacto-ovo vegetarian: Excludes meat, seafood, and poultry and includes eggs and dairy products.

Mediterranean: Similar to whole-foods, plant-based diet but allows small amounts of chicken, dairy products, eggs, and red meat once or twice per month. Fish and olive oil are encouraged. Fat is not restricted.

Whole-foods, plant-based, low-fat: Encourages plant foods in their whole form, especially vegetables, fruits, legumes, and seeds and nuts (in smaller amounts). For maximal health benefits this diet limits animal products. Total fat is generally restricted.

Designing the Right Combination of Plant based blend:

It is imperative that a balance of optimal nutrition is essential while following a plant based diet to strike a balance in macro , micro nutrient deficiency and understanding the allergy status(Jennifer et al., 2024)

Protein: Plant-based diets do not increase the risk of protein deficiency. Proteins are made up of amino acids. Those amino acids that cannot be synthesized by our body needs to be sourced from our diet. These essential amino acids are found in eggs ,meat and dairy products as well as many plant-based foods such as beans , millets , dhals /lentils , nuts, seeds,quinoa and potato. A combination of these foods are necessary to obtain essential amino acids through plant-based foods. Example: by including brown rice with dhal, and dhal chutney with millet dosa/pancake or hummus with millet breads. Therefore, a well-balanced, plant-based diet will provide adequate amounts of essential amino acids and prevent protein deficiency.

Soya sources in vegetarian diets are widely being studied and data published in the Journal of the American Medical Association reported that women with breast cancer who are on frequent intake of soy products had a 32% lower risk of breast cancer recurrence and a 29% decreased risk of death, compared with women who consumed little or no soy(Shu XO et al.2009). There was another analysis of 14 studies, published in the American Journal of Clinical Nutrition, showed that increased intake of soy resulted in a 26% reduction in prostate cancer risk(Yan L et al., 2009). However since the concerns of estrogenic nature in soy products, women with a history of breast cancer should discuss soy foods with their oncologists. Most importantly ultra-processed, mock meats are soy-based meat substitutes which are generally high in isolated soy proteins and other ingredients that may not be as healthy as less processed soy products (ie, tofu, tempeh, and soy milk) to be remembered while prescribing them.

Iron

Plant-based diets do contain adequate source of iron which is in non-haem form but the iron in plants if not meticulously planned can lower bioavailability. Since non-haem source needs to be combined with vitamin C for it's effective absorption . Plant-based foods that are rich in iron include green leafy vegetable , bean, figs, raisins,dates, cashews,niger seed,sprouts,millets, cabbage, and tomato juice.The American Dietetic Association states that iron-deficiency anemia is rare even in individuals who follow a plant-based diet(Craig et al., 2009).

Calcium and Vitamin D

Adequate intake of calcium can be achieved through well-balanced diet which is planned meticulously in plant-based diet. People who do not eat plants that contain high amounts of calcium may be at risk for impaired bone mineralization and fractures. However, studies have shown that fracture risk was similar for vegetarians and nonvegetarians irrespective of dietary preferences (Appleby P et al., 2007). Important sources of calcium includes sesame seeds,soya, tofu, drumstick leaves,amaranth leaves ,kale, millets etc. Finger millet or ragi is rich source of calcium but phytates that may hinder the absorption of calcium , hence sprouting reduces these anti-nutritional factors by increasing the bio-availability of calcium(Swati Puranik et al., 2017).

Fatty Acids:

Essential fatty acids are those which body does not synthesize but required to include in diet to maintain good health. Only two such essential fatty acids are known: linoleic acid (an omega-6 fatty acid) and alpha-linolenic acid (an omega-3 fatty acid). Three other fatty acids are only conditionally essential: palmitoleic acid (a monounsaturated fatty acid), lauric acid (a saturated fatty acid), and gamma-linolenic acid (an omega-6 fatty acid). Deficiency in essential fatty acids may manifest as skin, hair, and nail abnormalities.

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The fatty acids that vegans are most likely to be deficient in are the omega-3 fats (n-3 fats). Adequate intake of n-3 fats is associated with a reduced incidence of heart disease and stroke. Foods that are good sources of n-3 fats should be emphasized. They include ground oilseeds and vegetable oils.

Aim and Objective:

1. An attempt to formulate plant based blend to source vital nutrients like protein , iron , essential fats for those adopting to plant based diets .
2. To formulate a blend that provides an optimal amount of nutrients that help to promote sustainable diets.
3. To provide future scope in developing variation in blends as tube feed blend or can be converted to snack option.
4. As per research data commercial plant based supplements are source of heavy metal content (Clean label project) hence there is a need to develop safe blend.

Materials & Methods:

Ingredients to formulate plant based blend involved sprouted peas ,niger seed ,low glycaemic index potato & pumpkin seed.

- Dried peas were soaked in water overnight and sprouted for two days.
- Carisma Potatoes were used which is a low glycaemic index potato that are cleaned weighed along with the peel and chopped.
- Niger seed and pumpkin seeds are dry roasted mildly and powdered or cooked along with potato and sprouted green peas.
- The mixture is cooked and pureed into thick blend.
- The total nutritive value of 120ml formula provided 106kcal, 5.5g protein, 9.5g carbohydrate , 4.4g fat and 2 mg iron. Sprouted peas and low glycaemic index potatoes were leached , cooked and blended.
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Ingredients	Amount (g)	Energy kcal	Protein (g)	Carbohydrate (g)	Fat (g)	Potassium (mg)	Sodium (mg)	Phosphorous (mg)
***Potato**	10	7	0	1	0	54.1	0.4	4.3
Niger seeds	5	26	1	1	2	35.8	0.5	23.0
Peas dry	15	45	3	7	0	138.3	3.5	50.1
Pumpkin seeds	5	28	1.5	0.5	2.4	40.4	0.3	61
Total		106	5.5	9.5	4.4	268.6	4.7	138.4

Table :1 -for 120ml blend- Nutritive value as per Indian Food Composition Table 2017 & for pumpkin Seeds US Department of Agriculture was referred. * Carisma Potatoes were used

Ingredients	Amount (g)	Iron (mg)	Calcium (mg)	Omega 3(mg)	Total fiber(g)
***Potato**	10	0.0	1	3.1	0.1
Niger seeds	5	0.9	29	3.2	0.5
Peas dry	15	0.7	11	21.7	2.5
Pumpkin seeds	5	0.4	2	0.1	0.1
Total		2	43	28.1	3.2

Table :2 - for 120ml blend -Nutritive value as per Indian Food Composition Table 2017 & for pumpkin Seeds US Department of Agriculture & Joachim M. Dotto et al., 2020 was referred. * Carisma Potatoes were used

Ingredients	Amount (g)	Cost(Rs)
***Potato**	10	0.6
Niger seeds	5	2.4
Peas dry	15	3
Pumpkin seeds	5	4.5
Total		10.5

Table :3 – for 120ml of blend the cost is Rs 11. This can be diluted upto 150ml with water to provide through naso gastric tube or as pancakes (2no medium size) or as base to cook thick curries with added flavour & salt.

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Results & Discussion :

The end product can be used as a ready to use soup ,tube feed blend, as dosa or pancake and base for curries. The formula provides 20.7% of protein from energy with 10% of Recommended Dietary Allowance from 120ml with a potent source of iron, protein, essential fats and other micro nutrients which is vital while following a plant based diet. The use of low glycaemic index potato which is included in less proportion of 10g in 120 ml of blend to prevent glucose spike & potato . The overall cost of the product was 11 rupees (INR) for 120ml of blend.

Carisma Potatoes : Potatoes have gained popularity due to it's sustainability and nutritional benefits among the food industry and they offer valuable plant-based protein with high-nutritional-value amino acids(Rizwan Ahmed Bhutto et al., 2024). Potato protein has superior nutritional values and constitutes 19 different amino acids, including lysine, methionine, threonine, and tryptophan. Potato protein is highly digestible and has a balanced amino acid composition, and can be compared to egg and milk proteins (Schoenbeck et al., 2023). It contains 18 amino acids with high nutritional value that is superior to most plant-based proteins and close to the protein in eggs in this respect (Bártová et al., 2009). Additionally, potato protein contains a lot of lysine that can be used as a substitute for wheat to prevent wheat allergy (Vreugdenhil, Bradshaw, Gebhardt, Govers, & MacKerron, 2008). Potato proteins consists of glycoprotein (40 kDa), complex protein (22 kDa) and protease inhibitor, which have the potential function of foam formation and emulsion stabilization (Hannapel, Peterson, Estiekema, & Suh, 1990; Schmidt, Damgaard, Greve-Poulsen, Larsen, & Hammershoj, 2018). The research data suggests the potential application of potato protein in the food field. However, potato protein is prone to denaturation during the production process due to heat treatment, thus restricting its application in the food industry. Previous studies have shown that potato proteins as a crude extract dried by spray drying exhibited poor solubility and emulsifying properties (Renard & Christine, 2000), suggesting the necessity to modify potato protein to maximize its utilization.

Andersen et al. demonstrated that Carisma potatoes with a low GI (~53) are no different from Arizona potatoes with a high GI (~93) in their impact on satiety and ad libitum meal intake in a randomized, crossover, acute feeding trial in healthy adult men. It is a Non-GMO crop. Potato protein has superior nutritional values and constitutes 19 different amino acids, including lysine, methionine, threonine, and tryptophan.

Another study suggested the use of 30 g potato protein concentrate helps to increase muscle protein synthesis(MPS) rates at rest and during recovery from exercise in healthy, young males. Muscle protein synthesis rates after the ingestion of 30 g potato protein do not differ from rates observed after ingesting an equivalent amount of milk protein (Philippe J M Pinckaers et al.,2022).

Niger seed: Niger is considered as the most neglected oilseed crop (Suraj K. Padhi et al., 2023). Niger seeds are great source of more than 70% unsaturated fatty acids with wide range of medicinal benefits (Mohseni et al., 2020; Deme et al., 2017). Niger seed was commonly used in most northern states of Karnataka as Uchellu chutney which is the local name consisting of of a descent amount of omega-3 fatty acids, iron, calcium , crude fibre, a high amount of antioxidants such as phenol , tocopherols and sterols, with high level of vitamin K1 , magnesium ,potassium , zinc and beta-carotene which makes niger a nutritionally important crop with great health benefits (Ramadan, 2012). (Geleta et al., 2011; Ramadan, 2012; Deme et al., 2017). A study revealed that niger seed is an excellent source of essential metals and free from toxic metal such as Cadmium and hence safe for human consumption(Matiwes et al.,2017).

Pumpkin seeds: It is considered as functional food and nutraceutical ingredient for future. It is great source of essential fatty acid that has the potential to fight against carcinogens Since, seeds of pumpkin are abundant in magnesium, phosphorous, potassium, sodium and calcium and micro minerals like iron, copper, manganese, zinc and selenium, they can be used as an incredible dietary supplement which in turn helps in curbing various deficiency disorders .They are also enhanced in antioxidants such as polyphenols, flavonoids, phytosterols and squalene which makes it a lucrative raw material for pharmacological and food industries. Arunima Singh et al., 2024. Hematological parameters did not show any alterations. The results suggest that the hydroalcoholic extract from C. maxima. seeds, at a dose of 5000 mg/kg, presents a considerable safety margin, being devoid of acute toxicity(R.C.B. Cruz et al., 2006)

Green Peas: Pea protein is a superior protein with functional properties that is widely considered in global industry due to it's low allergenic and sustainability properties . It includes protein of (20–25%), fat (1.5–2.0%), carbohydrates in the form of starch (24–49%) and total dietary fiber (60–65%) including 10–15% insoluble fiber and 2–9% soluble fiber. They also contribute to non-starch carbohydrates, including sucrose, oligosaccharides, and cellulose. The minor constituents present are vitamins, minerals, phytic acid, saponins, polyphenols, and oxalates. The most prominent mineral element present in pea is potassium (1.04%) contained in the dry and dehulled weight of peas, followed by phosphorous (0.39%), magnesium (0.10%), and calcium (0.08%), respectively. Moreover, they are also a good source of water-soluble vitamins, particularly rich in B-group vitamins . The essential amino acids with a high lysine and threonine content are also present. However, it is deficient in sulfur-containing amino acids, including methionine and cysteine .

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Fig:1 Sprouted Peas

Fig:2 Pureed Blend

Fig:3 Pancake/Dosa

Conclusion : Plant based formula designed to optimize nutrient requirement as a source of vital nutrients such as protein , iron and essential fat through sustainable ingredients with an affordable cost which can be included as a tube feed blend or convert the same as pancake that can be a snack choice for those depending on plant based diet. This provides future research opportunity to develop , analyse and package this ready to feed blend which is vegetarian source , healthy , gut friendly and an initiative to design and encourage sustainable nutrition products .

Declaration of competing interest

The authors confirm that they have no conflicts of interest with respect to the work described in this manuscript.
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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