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Development of the instant soup mix with low GI ingredients and its consumer acceptability

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Abstract
The development and consumer acceptability of instant soup mix for diabetic patients that contains low glycemic index (GI) ingredients are the main objectives of this study. For people with diabetes who must keep tabs on their blood sugar levels, the idea is to offer an instant and balanced diet option. The study involves developing a soup mix with low GI foods such barley, carrot, cauliflower, spinach, tomato, onion and salt as well as analysing sensory evaluation done with standard method for consumer acceptability. The designed soup mix containing all low glycemic index ingredients, making it appropriate for those with diabetes. The developed soup mix were evaluated for their colour, appearance, consistency, flavor and overall acceptability. The soup mix is categorised in the name of FT-1, FT-2, FT-3, FT-4, FT-5 which are blended with low GI ingredients along with control. Among the five formulations FT-2 showed most acceptability. Overall, the research points to the possibility that the developed instant soup mix with low GI elements could be a good choice for diabetic people who need an instant and wholesome meal.

Keywords: glycemic index, diabetes, nutrition, instant soup mix, diet

1. Introduction
A sizable portion of the world's population is affected with diabetes, the third most common non-communicable disease. The definition of diabetes mellitus refers to a group of metabolic disorders that are linked to hyperglycaemia and brought on by partial or complete insulin deficiency (Egan & Dinneen, 2019) [6]. According to scientific data, the prevalence of diabetes mellitus is rising globally, especially in many developing nations (Shaw *et al*., 2010) [16]. An epidemiological study found that whereas diabetes mellitus, cardiovascular disease, and other diet-related illnesses were once considered "diseases of affluence" in wealthy nations, they are now spreading throughout many underdeveloped nations (WHO/FAO 2003) [27]. As it affects a sizable section of the population and manifests earlier in life, this is displaying a concerning trend (WHO/FAO 2003) [27]. Diabetes care systems require an integrated multidimensional approach involving general practitioners, proper diet plan, hospital specialists, other members of the health team (Organization & others, 2018) [15]. Nutrition therapy is an essential component of managing type 1 diabetes. The goals of nutrition therapy are to maintain optimal metabolic outcomes (i.e., blood glucose levels and lipid profiles), to prevent and treat chronic complications of the disease, and to support growth and development. Sugar just provides energy and no other nutrients but foods can be made to taste sweet and pleasant, and appetite can be increased, for example during illness (Khan & Sievenpiper, 2016) [11]. But overindulging in sweet foods can be bad for your health for a number of reasons. Foods that are sweet and sticky, such as desserts, snacks, and pastries made with plenty of sugar, honey, or syrup, are detrimental for the body and teeth if consumed frequently (Goldstein & Mintz, 2015) [8]. People who regularly consume sweet meals and drinks are more prone to gain weight and acquire diabetes. Low Glycemic index play vital role in a diabetic's diet. According to research, low GI substances have a positive impact on people's health. With the right diet and exercise, diabetics can easily be conquered. Restricting carbohydrates is the most significant thing that people can do to help themselves. The total reduction in energy intake was comparable as an effective dietary intervention (Harvey *et al*., 2018) [9]. Dietary carbohydrate restriction reliably reduces high blood glucose levels and shows weight loss (best to lose weight) and to reduce use of medicine (Feinman *et al*., 2015) [7]. (Bonora *et al*., 2001) [4] Normalising the blood glucose profile, including postprandial and fasting glucose levels, is one of the main goals of diabetes treatment. However, it was thought that starchy foods caused a much lower glycemic index

response than sugar did, so sugar consumption was limited for them. Then studies discovered that many starchy foods cause responses that are as high as similar glucose levels (potatoes have a high GI, while legumes have a low GI). Different glycemic index values might be found for foods with the same amount of carbs (Monro & Shaw, 2008) [13]. A HGI diet has been linked, according to several studies, to a higher risk of type 2 diabetes in people in good health. Only one food item with 50g of carbohydrates is referred to by the GI. Low-glycemic index diets enhance lipid profiles, lower C-reactive protein levels, slow weight gain, encourage higher levels of HDL cholesterol, and lower the risk of type 2 diabetes mellitus (T2DM) and cardiovascular illnesses (T. M. S. Wolever, 2013) [20]. The glycemic load (GL) of a specific dietary portion size describes how the food will affect blood sugar levels. A portion of food's carbohydrate content is taken into account by GL. An additional defence against the LGI diet is that postprandial glycaemia depends on factors other than GI classification, such as how much food is chewed and swallowed, how quickly each person's body digests and absorbs nutrients, how the meal is prepared, and the temperature of the food (Kirpitch & Maryniuk, 2011) [12]. Therefore, relying entirely on GI when planning a diet is too simplistic and might not lead to better postprandial glucose control.

Instant food is fairly common in modern society, because of the rising frequency of numerous health issues and our fast-paced society, there is a significant demand for meals with an additional health benefit (Carocho *et al*., 2014) [5]. Instant soups are so convenient and tasty, their solid ingredients have gained widespread favour throughout the world. Dietary fibre, found in fruits and vegetables, has been demonstrated to be helpful in preventing a number of ailments, including colon cancer, diabetes, diverticulitis, irritable bowel syndrome, diverticulitis, and cardiovascular disorders. Consuming these foods is also simple, nutrient-balancing, high fibre and low in fat (Islam *et al*., 2021) [10]. While considering into account low GI components in vegetables, fruits and cereals such peanut, barley, spinach, fermented soybean, carrot, broccoli, cauliflower, cabbage, tomato banana, apple, eggplant, strawberries etc.

Barley, carrot, spinach, cauliflower, tomato and onion are used in this soup mix which are categorized under low glycemic values. Barley has a low glycemic index and benefits a wide range of people, including diabetics and geriatric patients. Barley contains a healthy amount of nutrition that can balance physiological requirements (Beigh *et al*., 2020) [3]. Carrot seed extract's been found to be unworthy due to anti-diabetic, cholesterol- and cardiovascular disease-lowering, anti-hypertensive, hepatoprotective, anti-bacterial, anti-fungal, and for analgesic properties. In comparison to other vegetables, carrot also has a low glycemic index (Singh *et al*., 2019) [17]. (Morelock & Correll, 2008) [14] In addition to being high in beta carotene and folate, spinach is also a strong source of vitamin C, calcium, phosphorus, salt, and potassium, making it one of the most popular dark green leafy vegetables. Low glycemic index spinach with little impact on blood sugar. (Shidfar *et al*., 2011) [31] conducted a study to determine Lycopene, b-carotene, potassium, vitamin C, flavonoids, folate, and vitamin E are abundant in tomatoes and may help prevent type 2 diabetic people from developing the disease. This product will open a new window for food industry and a viable option for diabetic patients to meet a better diet

2. Review of literature

(Jenkins *et al*., 1987) [20] introduced the idea of the glycemic index (GI), as a way to classify carbohydrates based on the glycemic reaction they cause. When a standard amount of carbohydrate from a test food is consumed compared to that of a control food (either white bread or glucose), Ludwig defines the GI as "the incremental area under the glucose response curve. Non starchy vegetables, fruits, legumes, milk, yoghurt, and traditionally processed grains like wholegrain bread, pasta, and oats are categorised as having a low glycemic index (LGI) of foods. On the other hand, refined, starchy foods with a high glycemic index (HGI), such as white bread, processed cereals, potatoes, melons, and the majority of crackers.

According to (Rovner *et al*., 2009) [35] research, type 1 diabetics may experience less postprandial hyperglycaemia and post-absorptive hypoglycaemia by following a low-glycemic index (GI) diet. Diabetes mellitus (DM), a chronic condition caused by an inability of either insulin or its action to work properly, or both, results in delayed hyperglycaemia and ultimately affects metabolic processes within the human body (Bastaki, 2005)[6]. If left untreated, it will severely damage tissue and blood vessels, leading to major side effects such retinopathy, neuropathy, nephropathy, cardiovascular problems, and ulceration (Bearse *et al*., 2004;Seki *et al*., 2004; Looker *et al*., 2003). According to (Amos *et al*., 1997) [4], 300 million people will have diabetes worldwide by 2025, up from the estimated 200 million who had the disease in 2010.

In this study, type 1 diabetic children's blood glucose responses to and macronutrient content of low-GI meals were compared to typical meals eaten as often as possible at home. (Slavin & Green, 2007)[33] established that viscous soluble fibre has a major impact on postprandial glycemic and insulin responses because of how it affects stomach emptying and the absorption of macronutrients from the gut.

In long-term research, individuals with both insulin-dependent and non-insulin-dependent diabetes who follow low-GI diets see small improvements in their overall blood glucose management. The capacity of low-GI meals to decrease insulin release and lower blood lipid contents in patients with hypertriglyceridemia may be of higher therapeutic significance (T. M. Wolever *et al*., 1991) [19].

The meta-analysis by (Brand-Miller *et al*., 2003) [11] was very persuasive in favour of the LGI diet because it showed a total drop in HbA1c of 0.43% over and above what was achieved by following traditional dietary advice. Even though this might seem like a negligible percentage, any drop in HbA1c might be helpful for a diabetic's health. As of January 2008, the ADA's opinion was that "the use of glycemic index and load may give a little extra advantage over that observed when total carbohydrate is assessed alone.

There are strong positive correlations between the incidence of type 2 diabetes, coronary heart disease, gallbladder disease, and breast cancer, according to a meta-analysis by (Barclay *et al*., 2008) [2] that was published in the American Journal of Clinical Nutrition.

(Steve, 2015)[34] conducted research on four food items that have the potential to have an anti-diabetic effect. After analysing their findings, they came to the conclusion that these functional meals provide significant amounts of protein, fibre, and carbohydrates that are within the prescribed range for diabetes patients, as well as low glycaemic index and glycaemic load characteristics and antidiabetic actions. In essence, people with diabetes or those at risk of developing the

disease may benefit from the functional foods that have been developed. With the sanction of a higher authority, they conducted animal experiments. The food ingredients were turned into flour utilising home-based processing techniques, specifically fermentation and blanching. Additionally, these techniques were employed to enhance the food products' nutritional value.

Insoluble and soluble fibre were found to be inversely associated to the prevalence of type 2 diabetes mellitus in various prospective studies (Antonio *et al*., 2019) [5] . In order to delay the emergence and progression of chronic problems in diabetic patients, glycemic control improvement strategies have been suggested. A goal of glycated haemoglobin (HbA1c) of less than 7% has been proposed as the foundation for treatment decisions. The ideal approach to achieving this objective is to adopt healthy habits, including dietary adjustments, frequent physical activity, and adequate medication usage. Dietary therapy has a significant role in the management of diabetes. In contrast to earlier recommendations, the current dietary guidelines place more of an emphasis on encouraging wholesome eating patterns that include nutrient-rich, high-quality foods.

According to (Krejcova *et al*., 2007) [23], dry soups are essential for meeting the social needs of older people. Giving elderly people easy-to-eat, nutrient-rich foods is one method to prevent malnutrition and address their swallowing issues. One such product is dried soup powder, which is crucial in meeting both current and future social consumer demands. The flavour of dried soup powders is stable for a long time at room temperature and is protected from enzymatic and oxidative deterioration, among other benefits. The flavour of dried soup powders is stable at room temperature for lengthy periods of time (6–12 months) and is protected against enzymatic and oxidative deterioration. Additionally, they can be easily reconstituted for use as military rations as well as by the elderly, working families, hotels, hospitals, restaurants, and other institutions. A large portion of earlier research has been done on how to prepare dried vegetable soup before cooking. Instant soups were produced commercially in dried, canned, and frozen forms.

(Ahmad & Gani, 2021) [1] Evaluated the nutritional value of dry vegetable soup powder was the study's main goal. The findings imply that lentil and other pulse-based dry soups provide approximately twice as many micronutrients as other dry soups. This was also indicated by the nutritional density scores. When compared to what would be predicted given the soups' vegetable content, they found several B vitamins in much higher levels. Addition of yeast extract may have increased levels because it is said to be particularly high in thiamin, riboflavin, and niacin. They discovered that certain of the nutrients were measured at significantly higher levels than would be anticipated from the soups' vegetable contents, even though the majority of the nutrients that were detected in the dried vegetable soups presumably come from the dried vegetable powders. Similar to this, the higher potassium levels in tomato and onion soups may be due to the inclusion of potassium chloride as a salt substitute. They came to the conclusion that dry vegetable soups' nutrient density ratings were comparable to those of other soups and homemade soups. According to these studies, homemade soups and other dry vegetable soups can supply a sizable amount of the daily recommended vegetable and nutrient intake.

(Amadi *et al*., 2019) [2] They focused on a study to look into the glycemic and load response of non-diabetic females who consumed a variety of local vegetables in their diet. Studies on the glycemic index and load response of okra, African spinach, and lettuce sauces were few. Therefore, the purpose of this study was to evaluate various vegetable sauces' glycemic index and load response in healthy young people. The test food's recipe was created and standardised. On the test foods (okra, African spinach, and lettuce sauces) and the reference food (white bread), proximate and dietary fibre analyses was done. 36 non-diabetic students from Imo State University in Nigeria were chosen for the study after being screened for diabetes using the OGTT, glycated haemoglobin, anthropometric indices, blood pressure, and other exclusion criteria. African spinach and okra sauces, on the other hand, had lower fat content, more protein, and dietary fibre than lettuce and, due of their low glycemic index, load, and response potentials, should be suggested to type 2 diabetes mellitus patients when preparing their meals.

Research was done to examine underutilised crops including water chestnut and barley for the creation of low glycemic index (GI) muffins (Hussain SY *et al*., 2018) [18]. They got to the conclusion that it is possible to make low GI muffins with the appropriate sensory characteristics by replacing 30% of water chestnut flour (WCF) with barley flour. Barley flour (BF) addition significantly changed the glycemic response and qualitative characteristics of muffins. Due to the fact that bakery items with a high GI cannot be consumed by diabetics without raising blood glucose levels, this product was created. Water chestnut and barley have a low GI and can be used to create low GI bakery goods. The findings of this study open up new opportunities for the bakery business and provide diabetes patients with a healthy option for consuming baked goods.

(Eleazu, 2016) [14] looked into the benefits and drawbacks of low glycemic index (GI) and glycemic load (GL) meal suggestions for the dietary management of type 2 diabetes. There were also discussions over the validity and usefulness of glycemic load (GL) and glycemic index (GI) food analyses to the dietary management of type 2 diabetes. Any test on a product's GI and GL that aims to propose the item for the dietary treatment of type 2 diabetes could be balanced with glycated haemoglobin assays before they are embraced as helpful anti-diabetic foods, according to their research on the topic.

3. Material and methods

3.1 Development of soup mix with low GI ingredient

Carrot, cauliflower and spinach have been procured from College of Agriculture. Onion powder, tomato powder was collected from market in phagwara and made in to powder from the lab. Salt and barley also brought from the phagwara market. From above prepared low glycemic flour combinations most organoleptically most acceptable low glycemic flour selected for further analysis and management of diabetes.

Good quality of carrot, spinach, and cauliflower were collected from the University Campus.

All the vegetables were washed and blanched for different time intervals at 100°C *viz*. carrot (4-6) minutes, cauliflower (3-5) minutes, spinach (2-3) minutes respectively and chopped into smaller size. Vegetables have been dried in tray dryer at 60°C, carrot (10- 12) hours, spinach (5-6) hours, cauliflower (6-8) hours, tomato (12-16) hours, onion (6-8) hours respectively. Barley was roasted in a 60°C for 2-5 minutes.

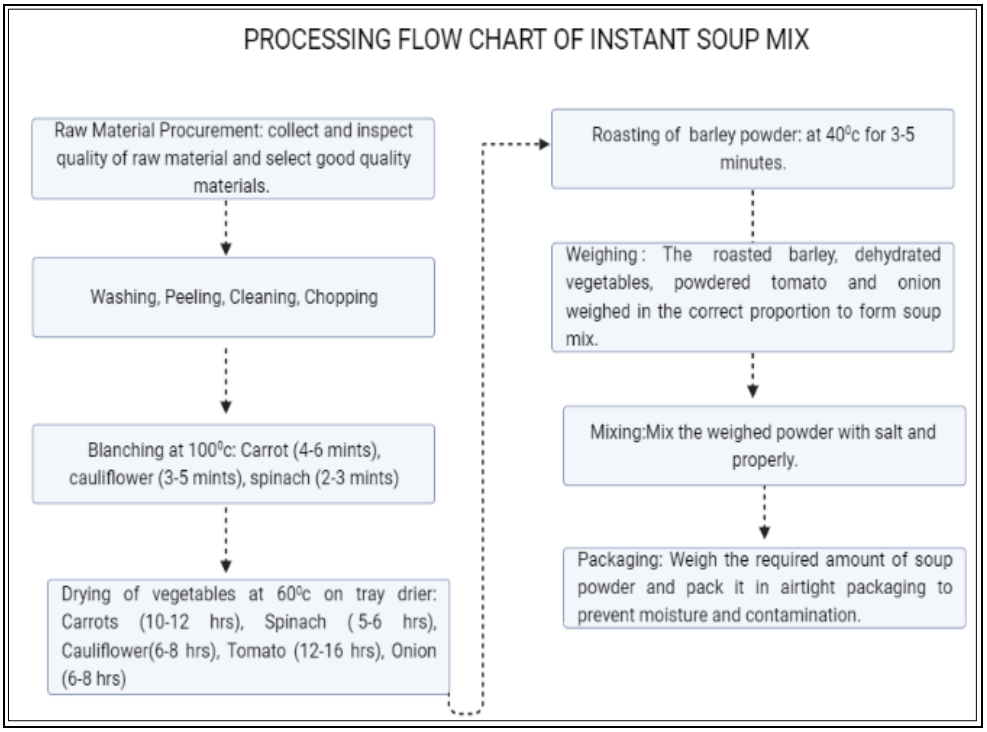

Fig 1: Processing flow chart of instant soup mix powder.

3.2 Sensory evaluation of products

The sensory quality characteristics of the items, such as colour and appearance, consistency, flavour, mouthfeel, and overall acceptability, were assessed by a group of 10 experienced judges using nine-point hedonic scales developed by (Amerine *et al*., 1965)[3].To assess the soup's sensory qualities, 25 grammes of soup sample are combined with 270 ml of water. These are what the scores represented: This nomenclature is used: "dislike extremely," "dislike very much," "dislike moderately," "dislike slightly," "neither like nor dislike," "slightly like," "moderately like," "very much like," and "extremely like."

4. Result and discussion

4.1 Different formulation of instant soup mixes with low GI ingredients

Different quantities of barley flour, carrot, cauliflower, spinach, tomato powder, and onion powder were used in various trials. Soup was made in accordance with the fundamental recipe previously indicated for soup with 30–70% roasted barley powder, 10–30% vegetables, 2–5% salt, and 7–10% tomato and onion powder (table 1). Considering earlier findings from acceptability trials of soup formulations, soup finally developed using the ideal level of ingredients to achieve desired formulations. Barley, carrots, spinach, and cauliflower varied for each of the five formulations while salt, tomato powder, and onion powder remained constant in concentration. 250 ml of water can be used to produce 25g of the soup mix.

4.2 Sensory attributes of instant soup mixes with low GI ingredients

The acceptance or rejection of the food is based largely on the stimulus of sense organs of an individual. On the basis of the sensory qualities appearance, consistency, flavour, taste and overall acceptability were evaluated by the experienced panel of judges. Different types of soup were developed using different formulations and subjected to sensory test on 9-point hedonic scale. The results of sensory analysis made from different ratios are given in Table 2. The control soup mix was the commercial Knorr's vegetable soup mixes. The control got highest value followed by FT-2 while FT-5 got the lowest value for all sensory attributes. The scores of controls for colour and appearance, consistency, flavour, mouthfeel and overall acceptability are 7.6, 6.6, 8.3, 8.3 and 7.30 respectively. Among the improved formulations the variation FT-2 scored highest scores than other variations for all the sensory characters *viz*, colour and appearance (6.3), consistency (7.6), flavour (7.6), mouthfeel (6.6) and overall acceptability (7.02). FT-2 consisting of good color and appreance, Liking consistency showshigh acceptance amoung judges which were similar to comercial one and flavour also moderate with out any kind of pungency. It was suggested that spinach usage be decreased in the formulations in FT-4 and FT-5 because the highlighting leafy flavour.

Table 1: Different formulation of instant soup mixes with low GI ingredients

Ingredients	FT-1%	FT-2%	FT -3%	FT-4%	FT-5%
Barley flour	80	75	70	65	60
Carrot	3	6	10	14	18
Spinach	1	2	2.5	3	3.5
Cauliflower	1	2	2.5	3	3.5
Tomato powder	5	5	5	5	5
Onion powder	3	3	3	3	3
Salt	7	7	7	7	7
Total %	100	100	100	100	100

Table 2: Sensory attributes of instant soup mix with Low GI ingredients

Treatment	Colour and appearance	consistency	flavor	mouthfeel	Overall acceptability
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
FT-1	5.2±0.15^{cb}	4.6±0.27^{a}	4.6±0.57^{a}	4.3±0.57^{a}	4.7±0.16^{a}
FT-2	6.3±0.17^{d}	7.6±0.25^{c}	7.6±0.57^{c}	6.6±0.57^{b}	7.02±0.52^{c}
FT-3	5.6±0.17^{cd}	6.6±0.27^{bc}	6.0±0.07^{b}	6.3±0.57^{b}	6.1±0.62^{b}
FT-4	4.6±0.27^{ab}	6.3±0.21^{b}	4.3±0.57^{a}	4.3±0.57^{a}	4.9±0.28^{a}
FT-5	4.0±0.03^{a}	4.6±0.23^{a}	3.6±0.57^{a}	4.6±0.57^{a}	4.2±0.43^{a}
Control	7.6±0.17^{e}	6.6±0.27^{bc}	8.3±0.57^{d}	8.3±0.57^{c}	7.7±0.25^{c}

Note= average of 15 sensory scores and maximum score out of 9. Values are means ±standard deviation of three determinations. Values with different super script on the same row are significant ($p \leq 0.05$).

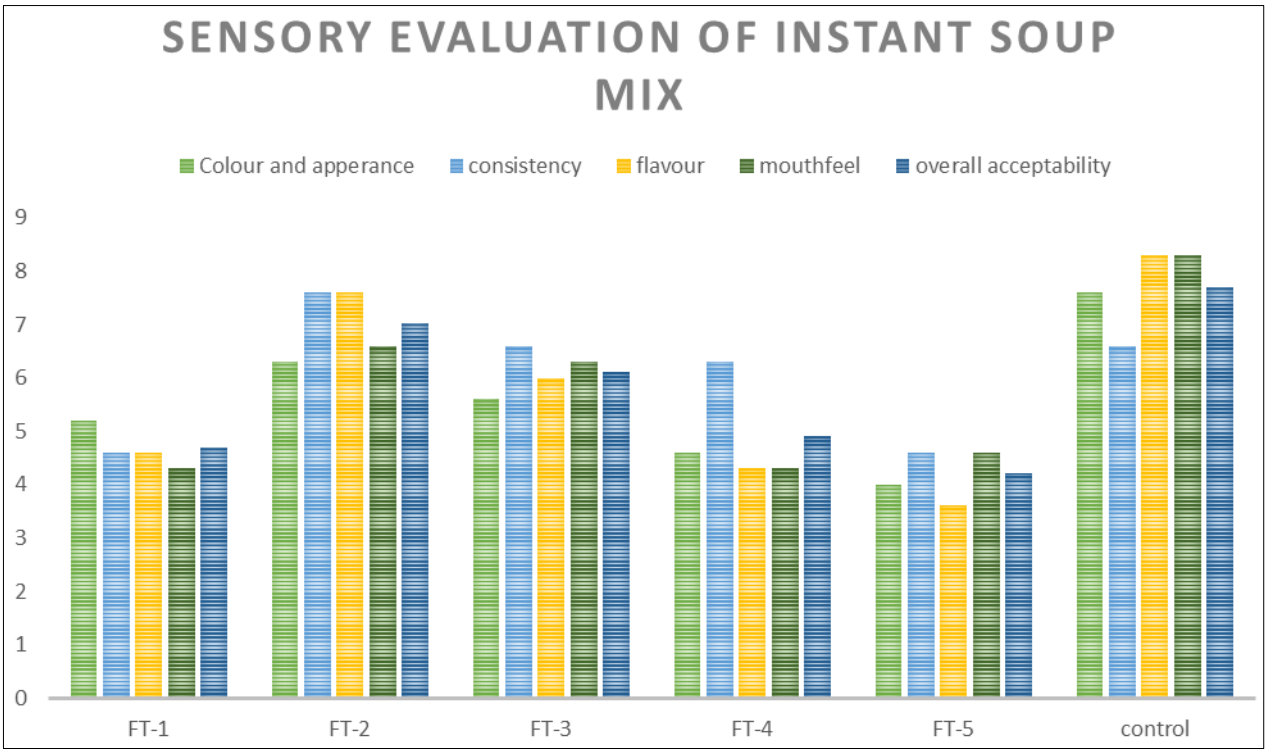

Fig 2: Sensory evaluation of instant soup mix with low GI ingredient

5. Conclusion

The potential of low glycemic index (GI) food in terms of nutrition and technology is significant. Research already indicates that low GI ingredients can be beneficial for reducing the risk of diabetes in diabetic patients. Among five soup mixes, FT-2 has demonstrated the highest level of acceptability. When preparing the soup, FT-2 exhibits good consistency, colour and flavor, which are crucial factors for consumer acceptance, followed by FT-3. Based on the findings, it can be concluded that FT-2 is the best formulation among all the alternatives. This study suggests that further research is required to develop an instant soup mix using low GI ingredients for large-scale commercial production. Additionally, quality evaluation is necessary to maintain nutritional enrichment in the product.

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