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RESEARCH ARTICLE

DEVELOPMENT OF GARCINIA CAMBOGIA ENRICHED NUTRI BITE FOR THE MANAGEMENT OF PCOS

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Abstract

Garcinia cambogia is a medicinal plant and natural dietary supplement. It has antioxidant and antimicrobial properties. Also known as Malabar tamarind in the west coast of South India, it is reminiscent to a pumpkin in appearance and is popularly used in the preparation of fish curries. The active component is α - β -dihydroxy tricarboxylic acid which improves exercise endurance and stimulates appetite suppression. Polycystic Ovarian Syndrome is a common endocrinopathy affecting women during their reproductive age. It has biochemical, physiological, psychological and reproductive health implications. Clinical studies propose significant outcomes of polycystic ovarian syndrome with lifestyle interventions including weight management. The aim of this study was to develop Garcinia cambogia enriched food product. Four variations with 1.5g (V1), 2.0g (V2), 2.5g (V3) and 3.0g (V4) of dehydrated dried Garcinia cambogia were developed incorporating oats (25%), wheat-bran (5%), peanuts (5%), almonds (5%), pumpkin seeds (5%), flaxseed (5%), dates (30%) and dark chocolate (15%) and subjected to organoleptic evaluation. The most acceptable variation was V1. The ash (4.14g+0.61), moisture (11.68g+1.14), carbohydrate (54.91g+3.09), protein (9.88g+0.27), crude fiber (5.49g+0.47), pH (3.7), magnesium and zinc content were estimated for V1. Further research is needed to explore the potential of Garcinia cambogia enriched food products vis-à-vis weight management and PCOS.

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Introduction:-

Polycystic ovarian syndrome (PCOS) is a common endocrinopathy that affects women during their reproductive age (Rjeshwari et al. 2016). This X-linked dominant condition manifests in the form of endocrine, psychological and behavioral changes. Hyperandrogenism (HA), anovulation, hirsutism, infertility, dysmenorrhea or amenorrhea, adrenarache, obesity, acne vulgaris (predominantly on the lower face, neck, chest and upper back), male pattern hair loss, insulin resistance (IR), reproductive disorders, psychiatric symptoms and decreased quality of life (QOL) are characteristic of PCOS. It is a product of the complex interaction between genetic factors including prenatal exposure to high androgen levels, epigenetic factors, and environmental factors such as diet, physical activity, smoking and stress (Tsikouras et al. 2015). Women with PCOS are susceptible to male type fat distribution due to

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the effect of HA (Choudhary et al., 2017). In 2012, about 116 million women were affected by PCOS according to the WHO (Bharathi et al., 2017). PCOS occurs at a frequency of 11.2% of women of reproductive age and in 50% of teenage girls (Choudhary et al., 2017). Up to 70% of the women remain undiagnosed with PCOS. The prevalence of PCOS ranges from 2-20%. The Indian Fertility Society reported that the prevalence of PCOS is 3.7-22.5% in India (Vidya Bharathi et al., 2017). The long-term implications of PCOS make early diagnosis imperative in the treatment of PCOS. The management of PCOS is symptom specific and focuses on support and education with the integration of lifestyle modifications, pharmacological therapy, nutritional counseling and exercise. This multidisciplinary approach is essential to mitigate the heterogeneous nature of PCOS and help ameliorate the threat of diabetes by instigating weight loss, improving IR, HA and glucose metabolism (Elmenim & Emam, 2016). The immense intricacy in diagnostic criteria and its indefinites makes PCOS a challenging area of research. Pasquali et al. emphasizes that analysis of predisposing factors such as environmental and genetic factors associated with elevated risk of PCOS are potential areas of research (Pasquali et al., 2011). Various studies implicate the use of hypocaloric diets to improve the body composition by influencing reduction in fat mass, abdominal fat mass and weight circumference in overweight obese PCOS women (Thompson et al., 2008). Hypocaloric diets have been associated with sporadic ovulation in a significant number of patients with PCOS and reduction of HA and IR thus improving reproductive health (Jarrett & Lujan, 2017). Faghfoori et al. suggests a diet with high carbohydrate (55%), average protein (15%) and low fat (30%) supported by regular physical activity. Low-glycemic index (GI) diets are associated with reduced risk of metabolic syndrome and cardiovascular diseases and reduce IR. Consumption of dietary fiber lowered the risk of fertility disorders due to ovulation disorders by 44% in women of age 32 and above (Szczuko et al. 2016). The consumption of saturated fatty acids and trans-fatty acids influences IR as they contribute to reduced insulin sensitivity. Low levels of serum magnesium, zinc, and selenium in PCOS women have been indicated to influence IR (Rajeswari et al. 2016). Low GI diets are associated with reduced risk of metabolic syndrome and cardiovascular diseases and reduce IR. Hence the type of carbohydrate consumed may influence metabolic health to a major degree. Consumption of dietary fiber lowered the risk of fertility disorders due to ovulation disorders by 44% in women of age 32 and above. (Szczuko et al. 2016). IR is said to be influenced by the consumption of saturated fatty acids and trans-fatty acids as they contribute to reduced insulin sensitivity. *Garcinia cambogia* (GC) is a medicinal plant and a natural dietary supplement. GC is a small green fruit native to India, Nepal and Sri Lanka. Also known as Malabar tamarind in the west coast of South India, it is reminiscent to a pumpkin in appearance and is popularly used in the preparation of fish curries. This fruit has been used as a potential dietary supplement for weight management in recent years and has been termed as 'Nature's Natural Fat Buster' or 'Remarkable Herb' (Gopakumar, & M S, 2014). This low GI fruit has been known to possess antioxidant and antimicrobial properties and is used in the treatment of constipation, rheumatism, intestinal parasites and edema. The active component in the fruit rind is an organic acid, α - β -dihydroxy tricarboxylic acid (HCA) which suppresses appetite by regulating the release of serotonin by the brain. It inhibits adenosine triphosphate-citrate-lyase enzyme and thereby inhibits lipogenesis. This enzyme is responsible for the conversion of citrate to acetyl-coenzyme A and fatty acid synthesis. HCA increases lipid oxidation and decreases carbohydrate metabolism thus improving exercise endurance and stimulating appetite suppression (Onakpoya et al., 2011). This component has been reported to be a key active ingredient contributing to weight loss, making GC a common weight loss supplement. Other bioactive components of GC including benzophenones are reported to reduce oxidative stress levels based on in-vitro experiments in human plasma, hence GC may protect against diseases associated with oxidative stress. GC is also reported to suppress cholesterol and triglyceride accumulation in high fat diet fed mice. Yadav et al. states that the effect of HCA in animals is maximum when administered 30-60 minutes prior to feeding (Yadav et al., 2016). It has been indicated to ameliorate symptoms of PCOS as it has lipolytic and antihyperglycemic effects (Londe and Agarwal 2017). Clinical and animal studies have however reported cases on GC induced hepatotoxicity, the exact mechanism of which remains still unclear. It was first demonstrated that it increased hepatic collagen accumulation, lipid peroxidation and mRNA levels of genes related to oxidative stress (superoxide dismutase and glutathione peroxidase), inflammatory responses (TNF- α and monocyte chemoattractant protein-1) as well as plasma alanine transaminase and aspartate transaminase levels in a study on mice (Kim et al., 2013). It is evident that portion size is proportional to consumption of food and a larger portion size contributes to higher food consumption. This factor is contributory to increased prevalence of obesity. Hence nutri-dense bite sized food products may actually aid in food portion size control and may help mitigate obesity. There is a paucity in the variety of products of GC restricted to extracts and dietary supplements.

Methodology:-

The study was multi-phased. The first phase involved the processing of GC and preparation of standardized *Garcinia* Bite. Dried GC was first cleaned, inspected to remove damage, disease or pest infected fruits and cut into small

pieces and oven dried at 100°C for 10 minutes. The dehydrated fruit rind was ground to a fine powder and stored at 4°C. Oats (25%), wheat bran (5%), peanuts (5%), almonds (5%), pumpkin seeds (5%), and flaxseed (5%) were roasted and processed to powders. Dates (30%) were heated and incorporated along with dark chocolate (15%) and the powdered ingredients including processed GC. The mixture was further molded into bite sized portions weighing 15g each. Four variations were prepared with 1.5g, 2.0g, 2.5g and 3.0g of GC powder per 15g of the garcinia bite. The second phase of this study dealt with sensory evaluation utilizing Quantitative Descriptive Analysis method and using tests of preferences (Hedonic) with 22 semi-trained panelist to assess the parameters of appearance, texture, flavor, taste, color and overall acceptance of the food product.

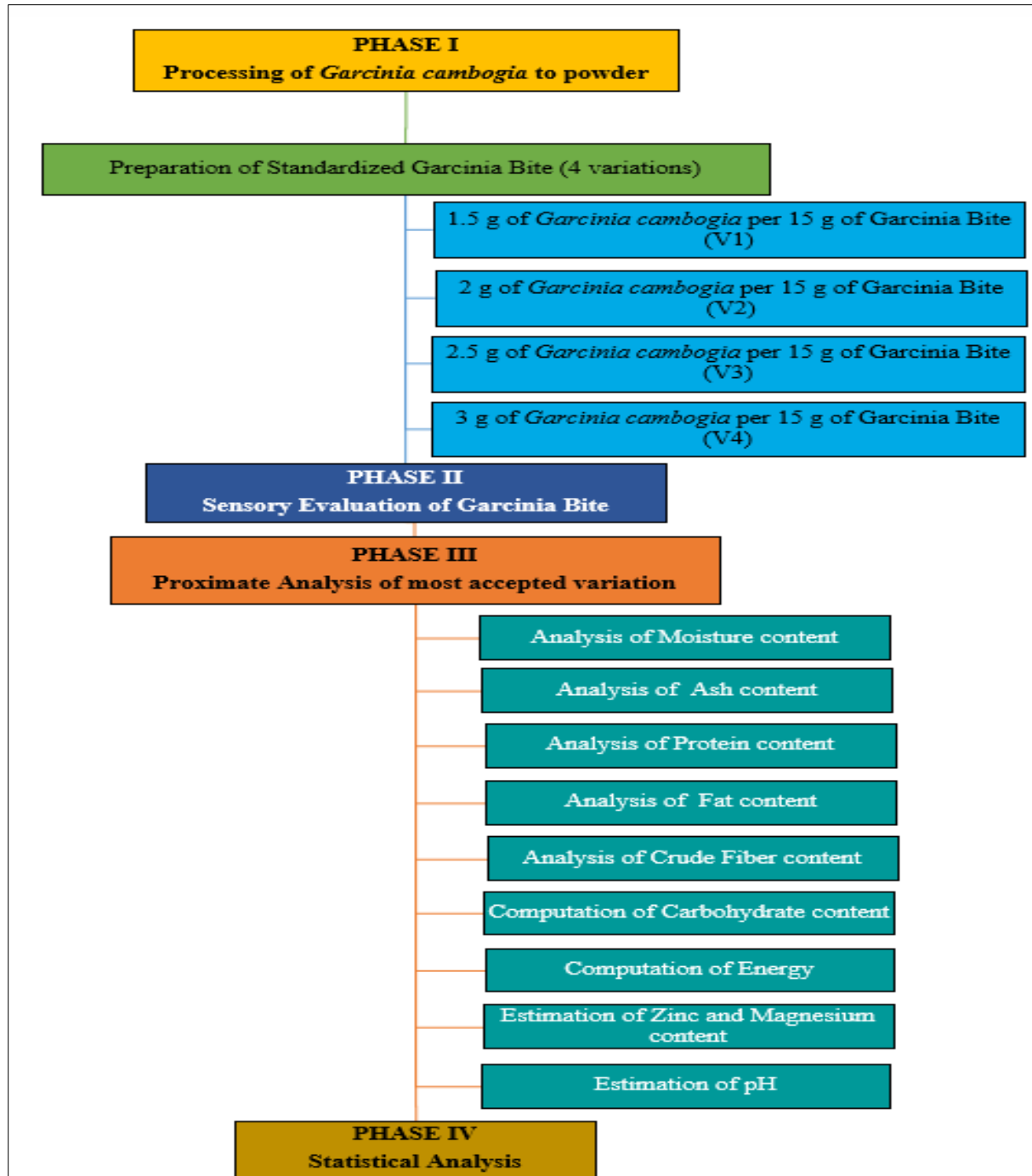


Figure 1: Research Design.

There are 9 grades in the hedonic test assessment, namely 1= dislike extremely, 2=dislike very much, 3= dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, 9 = like extremely. Proximate Analysis of Standardized Garcinia Bite encompassed the third phase. Proximate parameters of moisture, ash, protein (Kjeldahl method $N \times 6.38$), lipid (Soxhlet extraction), crude fiber, pH, magnesium and zinc contents were assessed for the most accepted variation in accordance to the Association of Analytical Communities (AOAC, 2000).

Estimation of Moisture: The moisture content was analyzed in accordance to AOAC (2000). 5g of the dried sample was taken in a sterilized flat bottomed dish (pre-weighed) and kept for 6 hours in a hot air oven at 100-110°C and weighed. The loss in weight was regarded as a measure of moisture content and was calculated as follows: $\text{Moisture (\%)} = \frac{\text{Weight of fresh sample} - \text{Weight of dry sample}}{\text{Weight of fresh sample}} \times 100$ (Shahnawaz et al., 2013).

Estimation of Ash Content: According to the AOAC (2000), 5g of the sample was weighed in a silica crucible and heated in a muffle furnace for about 3 to 5 hours at 500°C till white or greyish white ash was obtained. The cooled crucibles were kept in the desiccator to cool further and weighed. The ash content was calculated as: $\text{Ash (\%)} = \frac{\text{Weight of sample after ashing}}{\text{Weight of fresh sample taken}} \times 100$ (Shahnawaz et al., 2013).

Estimation of Protein: The estimation of protein is determined on the basis of the total nitrogen content in foods utilizing the Kjeldahl method (AOAC, 2000). Kelplus Nitrogen Analyzer was utilized to estimate the protein content.

Estimation of Fat: The percentage fat was estimated by Soxhlet extraction using the Socs plus Automatic Solvent/Fat Extraction System. The principle is based on the separation of sample components on the basis of the physical and chemical (solubility) properties.

Estimation of Crude Fiber: Fibra plus Automatic Fiber Estimation System was utilized to estimate the crude fiber content according to the method of AOAC, 2000.

Computation of Energy (AOAC, 1980): The energy was estimated as per AOAC, 1980 given as: $\text{Energy (kcal)} = [\text{Protein (g)} \times 4] + [\text{Carbohydrate (g)} \times 4] + [\text{Fat (g)} \times 9]$

Computation of Carbohydrate (AOAC, 1980): The carbohydrate content was determined by difference, that is, addition of all the percentages of moisture, fat, crude protein, crude fiber and ash were subtracted from 100%. This gave the amount of nitrogen-free extract otherwise known as carbohydrate. $\text{Carbohydrate (\%)} = 100 - [\text{Crude protein (\%)} + \text{fat (\%)} + \text{moisture (\%)} + \text{ash (\%)} + \text{Crude fiber (\%)}]$ (Sohaimy et al., 2015).

Estimation of Magnesium and Zinc Content: The mineral analysis was outsourced from Scientific and Industrial Research Center Bangalore. These tests were carried out in an ISO 9001 and OHSAS 18001 certified laboratory.

Estimation of pH: A digital pH meter was used to determine the pH of the food sample using the AOAC 2000 method. The pH meter was calibrated with buffers at pH 4 and 10. Sample solution was taken in the beaker and inserted. When the first reading was completed, the electrode was washed with distilled water and dried with tissue paper (Shahnawaz et al., 2013).

The final phase of the study concluded with Statistical Analysis.

Statistical Analysis:

Results obtained were subjected to statistical analysis. Results of sensory evaluation and the mean and standard deviation of proximate parameters was analyzed. The coefficient correlation amongst the proximate parameters was observed.

Results And Discussion:-

The test results of sensory attributes to determine the effect intensity of the sensory attributes of the food product is presented in figure 2. V1 was found to be the most acceptable variation. Table 1 represents the parameters of proximate analysis of V1.

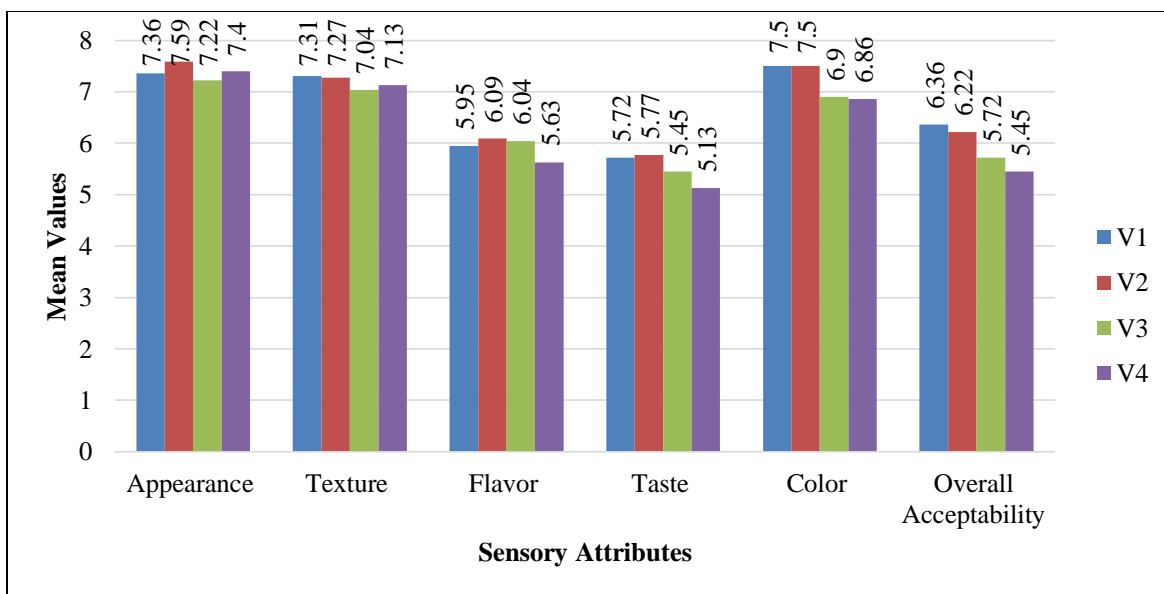


Figure 2:- Sensory Attributes of Garcinia Bite of V1, V2, V3 and V4.

Table 1:- Results of Proximate Analysis of Garcinia bite (V1).

	Moisture (g 100 ⁻¹ g)	Ash (g100 ⁻¹ g)	Protein (g100 ⁻¹ g)	Fat (g100 ⁻¹ g)	Crude fiber (g100 ⁻¹ g)	Carbohydrate (g100 ⁻¹ g)	Energy (kcal100 ⁻¹ g)
Mean	11.68	4.14	9.88	13.88	5.46	54.91	384.14
SD	1.14	0.61	0.27	2.74	0.47	3.09	12.84

Table 2:- Correlation Coefficient between Dietary Parameters of Garcinia Bite.

Correlation Coefficient	Moisture (g)	Ash (g)	Protein (g)	Fat (g)	Dietary Fiber (g)	Carbohydrate (g)	Energy (Kcal)
Moisture (g)	1.0000						
Ash (g)	- 0.8741**	1.0000					
Protein (g)	0.9721**	-0.7358**	1.0000				
Fat (g)	0.1504 ^{NS}	0.3486 ^{NS}	0.3781 ^{NS}	1.0000			
Dietary Fiber (g)	-0.9806**	0.7620**	- 0.9992**	- 0.3412 ^{NS}	1.0000		
Carbohydrate (g)	-0.2639 ^{NS}	- 0.2377 ^{NS}	- 0.4828*	- 0.9932**	0.4478*	1.0000	
Energy (Kcal)	0.1175 ^{NS}	0.3795 ^{NS}	0.3472 ^{NS}	0.9994**	- 0.3098 ^{NS}	- 0.9888**	1.0000

** Significant at 1% level * Significant at 5% level NS Not significant.

The results of proximate analysis (Table 1) revealed that the food product may be a good source of nutrition and natural energy with crude protein content- $9.88 \pm 0.27 \text{g}100\text{g}^{-1}$, carbohydrate content $54.91 \pm 3.09 \text{g}100\text{g}^{-1}$ and energy- $384.14 \pm 12.84 \text{kcal}100\text{g}^{-1}$. The moisture content ($11.68 \pm 1.14 \text{g}100\text{g}^{-1}$) in food determines the quality of shelf-life and indicated that the food product cannot be stored at room temperature for long duration. Ash content ($4.14 \pm 0.61 \text{g}100\text{g}^{-1}$) reported a high mineral matter extent indicating that the food product is a good source of minerals. The magnesium and zinc content was found to be $4.8 \text{mg}1000\text{g}^{-1}$ and $53.82 \text{mg}1000\text{g}^{-1}$ respectively. The fat content ($13.88 \pm 2.74 \text{g}100\text{g}^{-1}$) of the food product can be attributed to the incorporation of flaxseeds, almonds, peanuts and pumpkin seeds. The food product was found to be a good source of fiber (crude fiber content- $5.46 \pm 0.47 \text{g}100\text{g}^{-1}$) due to the presence of oats, wheat bran and flaxseeds. A mean pH of 3.7 was observed and was thought to be due to the acidic nature of HCA. Table 2 showcases the simple correlation coefficients between the proximate parameters. Results indicate that moisture content of the product was significantly negatively correlated to the ash and dietary fiber but significantly positively correlated to protein content. The ash content was observed to be significantly negatively correlated to protein and significantly positively correlated to dietary fiber. Protein content of garcinia bite was also negatively correlated to dietary fiber and carbohydrate content. The fat content showed a significant negative correlation to carbohydrate content but a significant positive correlation to the

computed energy. A significant negative correlation was observed between the estimated carbohydrate and energy of garcinia bite.

Conclusion:-

The findings of the study inferred that the food product had low keeping quality and requires refrigeration. A good mineral profile was detected from the ash content. Pumpkin seeds are rich in magnesium, phosphorous, calcium, manganese, copper and zinc (Devi et al., 2018). The food product was further found to be a good source of energy and crude protein. The modest increase of protein content at the expense of other macronutrients may induce satiety and mediate weight loss through reduced energy consumption (Paddon-Jones et al., 2008). The inclusion of functional ingredients such as flaxseeds, oats and wheat bran improved the crude fiber content of the food product. Clinical studies have emphasized the hypocholesteremic effects of oats in addition to its role in improving glucose tolerance, glycemic control and especially with respect to the magnitude of the postprandial glucose (PPG) and insulin responses (Webster & Wood, 2011). Wheat bran has been shown to significantly reduce PPG response of subjects with impaired fasting glucose (IFG) and improve serum cholesterol levels and aid in the mitigation of dyslipidemia commonly seen in PCOS (Ghanei, et al., 2013). This characteristic may aid in suppressing appetite; as protein and fiber rich foods are known to induce satiety (Poutanen et al., 2017). Flaxseeds contain Ω -3 fatty acid, α -linoleic acid (ALA) and other bioactive compounds that have been associated with improving the lipid profile (Machado et al., 2013). Almonds have also been found to contain phytosterols which on ingestion mimic the structural and functional properties of cholesterol and compete with low-density- lipoprotein-cholesterol (LDL-C) and contribute to reduced serum LDL-C within blood vessels (Akram et al., 2018). These features have been associated with improving the lipid profile and management of dyslipidemia for PCOS subjects. There is a scarcity in the diversity of food products containing GC. Further research is required to study the nutritional aspects that correlate factors for prevention and mitigation of PCOS and hopefully explore the potential benefits of GC enriched food products.

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