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Investigate the Effect of Using Jojoba and Moringa Protein Concentrate as a Fat Mimetic on Physical and Sensory Properties of Cup Cake

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Abstract: There is a need to explore the utilization of new protein ingredients in the formulation of new food products or to enrich the traditional formulations. Then, Jojoba (Simmondsia chinesis) and Moringa (Moringa olifeira) defatted seed meals is an inexpensive protein source with good nutritional quality and properties. The objective of this study was to examine the protein concentrate of Jojoba and Moringa as a Fat Mimetic on Physical and Sensory Properties of Cup Cake. Fat replacers can be used to help decrease the amount of fats used in cooking, therefore these health risks can be reduced. This study showed that Sensory quality was assessed by ten experienced panelists from Desert Research center, using attributes such as bread taste, flavor, firmness, softness, crumb and crust colors, appearance and overall acceptability. Principal components and cluster analyses confirmed two groupings of treatments with protein concentrate of Jojoba and Moringa as a fat mimetic. The results indicated that the moisture increased and its specific volume decreased in final product with the increase of protein concentrate of jojoba and moringa. Also, Sensory properties of the cupcake samples we introduced the sample containing 25% protein concentrate of jojoba and moringa as the best sample. Then, the second level was acceptance in the study was content 50% of protein concentrate of jojoba and moringa. Based on results, the increase in protein concentrate contents of the sample to 75% led to reducing in quality cupcakes products. Finally, protein concentrate of jojoba and M. olifeira presented good functionality for utilization in food formulations.

Keywords: Jojoba, Moringa, Protein Concentrate, Fat Mimetic and Cup Cake

1. Introduction

Today, the consumers prefer low-calorie, low-fat, and low-cholesterol ready-to-eat foods, namely healthy foods and are aware of the relationship between diets and disease development. Given the efforts made to reduce the incidence of diseases such as cancers, cardiovascular, coronary heart disease and to improve the health status, development of foods rich in vegetable and anticancer compounds may play a major role in securing the health of consumers [27]. Among baked products, cakes are especially popular being perceived as a delicious product with special organoleptic properties [17]. Cakes are produced in various types being a favorite food especially among children and juveniles. It is a kind of sweet with a special soft, texture being classified as a baked product. Its main ingredients include flour, oil, sugar, and eggs [18]. Cakes are the most consumed bakery product owing to unique products and are always used in festivals as well as in joyous celebrations [9].

The role of proteins in human nutrition is substantial. According to Modern Nutrition Recommendations, human beings should rely mostly on vegetable and legume proteins to meet the protein requirement in their diet. In addition to their nutritional value, proteins provide great potential as functional food ingredients enhancing the useful properties when incorporated into food commodities. In order to utilize a byproduct as a protein source, it should contain high protein content and protein value (quality) based on well-balanced essential amino acids [19]. Protein and calorie malnutrition is one of the most widespread problems in developing countries.

The most disastrous consequences occur in children where protein energy malnutrition manifests itself in forms of two serious diseases: marasmus and kwashiorkor. Plant proteins are therefore important in the diet of children because animal proteins are unavailable due to high price [16].

As a food component, fat contributes key sensory and physiological benefits. Fat contributes to flavor, or the combined perception of mouthfeel, taste, and aroma/odor [25]. Fat also contributes to creaminess, appearance, palatability, texture, and lubricity of foods and increases the feeling of satiety during meals [23]. Fat can also carry lipophilic flavor compounds, act as a precursor for flavor development (e.g., by lipolysis or frying), and stabilize flavor [24]. From a physiological standpoint, fat is a source of fat-soluble vitamins, essential fatty acids, precursors for prostaglandins, and is a carrier for lipophilic drugs [6]. Fat is the most concentrated source of energy in the diet, providing 9 kcal/g compared to 4 kcal/g for proteins and carbohydrates.

Fat may be replaced in food products by traditional techniques such as substituting water [5], or air for fat, using lean meats in frozen entrées [10], skim milk instead of whole milk [33], in frozen desserts and baking instead of frying [30], for manufacturing or preparing snack foods; Some lipids may be replaced in foods by reformulating with selected ingredients that provide some fat-like attributes [28]. These fat replacers can be lipid, protein or carbohydrate-based and can be used alone or in unique combinations [26].

Fat replacers are generally categorized into two groups: fat substitutes and fat mimetics. Fat substitutes are ingredients that have a chemical structure somewhat close to fats and have similar physiochemical properties [22]. They are usually either indigestible or contribute lower calories on a per gram basis. Fat mimetics are ingredients that have distinctly different chemical structures from fat. They are usually carbohydrate and/or protein-based. They have diverse functional properties that mimic some of the characteristic physiochemical attributes and desirable eating qualities of fat: viscosity, mouthfeel and appearance [11].

Jojoba (Simmondsia chinensis) is an oil yielding desert shrub (family Simmondsiaceae) of arid and semi-arid areas [14]. Commercially jojoba is grown for its oil which having lubricating properties. Besides being known for its lubrication, jojoba has attracted interest towards, cosmetics, pharmaceuticals, animal feeding, and landscape as soil conservation [31]. Jojoba seeds have also been used in cleaning of aquatic system mainly for the removal of access ferric ions [3]. After oil extraction its defatted meal, represent a potential supplement for animal feeds. Once defatted, the major constituents of it are proteins (31%) and carbohydrates (55%) [13]. Jojoba industry faces the challenge of finding ways to improve productivity and quality of the products. There are number of different jojoba accessions which are grown in jojoba farms. This is mandatory to comparably evaluate them for its commercially important chemical properties.

Moringa oleifera (Moringaceae), is a perennial foliaged tree, widely cultivated due to its high adaptability to climatic conditions and dry soils [21]. It is considered as one of the most useful trees in the world because almost all parts of this plant can be used as food, in medicines and for industrial purposes [12]. M. oleifera has been used in several developing countries to prevent protein-energy malnutrition especially among children at an early age and pregnant women [20]. The relative lack of anti-nutritional components and the high protein, lipid and sulphur containing amino acid contents encourage the use of moringa seed as an animal feed. It is an excellent source of proteins for monogastric animals [8]. The antioxidant action of some compounds present in the plant, one of the most important physiological roles of food, can protect organisms against the deleterious effects of oxidation.

Thus, the aim of this study were to investigate the feasibility of using the Jojoba and Moringa protein concentrate as a fat mimetic and to study its effect on on physical and sensory properties of cupcake. For this purpose, seven different formulations were examined which was the control cake (without protein concentrate) and cake with fat replacement of 25, 50 and 75% w/w.

2. Materials and Methods

2.1. Preparation of Protein Concentrate

The concentrates from pressed meal were prepared according to methods described in Wiseman and Price [32]. A pressed cake (meal) was obtained from a press operation and extracted with hexane until the solvent was no longer colored. The defatted meal was spread out in trays to dry overnight at 20°C. the defatted meal was subsequently ground with a hammer mill through 60 mesh screen. Protein concentrate were obtained by extracting the defatted meal with hexane solvent (1:20, w/v) at 20°C. SDI (spray-dried concentrate I) was obtained after washing the meal with methanol / acetone (3:1). and by rewashing SDI protein concentrate with a solution of methanol and IN HC1 (98:2) (SDII).

2.2. Processing of Cupcakes Formulas

Raw ingredients of processed cupcake and all formulas of substituted wheat flour at different substitution levels by both Protein Concentrate were summarized in Table (1) and (2). The processing method of cupcake was taken typically according to A. A. C. C. [2]. in steps sequence as: The shortening was melted thoroughly; sugar and salt were added then mixed vigorously. The whole egg was mixed with vanillia and whipped until got puff and smooth like-cream texture. Additionally, substituted wheat flour (72% extraction) with baking powder and skimmed milk powder then added gradually to whipped egg mixture. This mixture was mixed gently until got homogenous dough using Hand mixer (MK-H4-W, Panasonic Co). After getting appropriate texture the dough was poured into paper cups and backed at 180°C ± 5°C for 30 - 35 min. The baked cupcakes were cooled down at room temperature, then packed into aluminum foil bags intervals for analysis. six fat mixes were prepared from jojoba protein with shortening and moringa protein with shortening as shown in table (2).

Table 1. *Raw ingredients of processed cupcake.*

Ingredients	Weight (g)
Soft wheat flour (72% extraction)	250
Sugar	125
Salt	3.5
Skimmed milk powder	25
Shortening	53.5
Fresh whole egg	110
Baking powder	12.5
Vanilla	2

Table 2. *Formula of the cupcakes.*

Jojoba				Moringa			
Sample	**Shortening**	**Jojoba protein**	**Fat (%)**	**Sample**	**Shortening**	**Moringa protein**	**Fat (%)**
Control	53.5	-	100	Control	53.5	-	100
JP 25	40	13.5	75	MP 25	40	13.5	75
JP 50	26.75	26.75	50	MP 50	26.75	26.75	50
JP 75	13.5	40	25	MP 75	13.5	40	25

2.3. Proximate Analysis

Water, protein, fat, crude fiber, ash, contents of the raw materials and the cupcakes were determined according to the methods of AOAC. [4]. Total carbohydrates (TC) were calculated by difference.

2.4. Amino Acids

Amino acids were determined using a BECKMAN 6300 amino acid analyzer according to the method of Spackman, Stein, and Moore [29]. Hydrolysis of samples was performed in the presence of 6 M HCl, trifluoroacetic acid (TFA, 2:1, v/v) and 5% thioglycolic acid, for 24 h at 100°C. Prior to amino acid Analysis.

2.5. Physical Characteristics

Physical characteristics: The normal weight of baked cupcakes was individually determined within 1 h after baking. Also, volume in different substituted cupcakes was determined by method according to (AACC) [1], and specific volume were calculated for these formulas. [Volume (cm3) / Weight (g)]

2.6. Sensory Evaluation

Cupcakes were evaluated for its sensory characteristics, i.e., taste, odor, appearance, crust color, crumb color and crumb texture. The evaluation was carried out by ten experienced panelists from Desert Research center, according to the method of Larmond [15]. A 9-point scale was used for the sensory evaluation: (1) very bad, (2) bad, (3) poor, (4) relatively poor, (5) intermediate, (6) good, (7) very good, (8) excellent, and (9) very excellent.

3. Results and Discussion

3.1. Proximate Composition and Yield of Protein Concentration

The proximate composition of jojoba and moringa defatted seed meal is presented in figure 1. Protein was the major macromolecule in jojoba defatted seed meal (35.8%) after carbohydrates (43.2%). Higher protein content values were reported for moringa defatted seed meal (58.4%). Jojoba meal reported higher content of fiber, moisture and ash (13.1, 3.9 and 3.7% respectively) than moringa meal (4.9, 2.7 and 2.3% respectively). Protein content was significantly ($p < 0.05$) higher in M. oleifera meal compared to jojoba meal. Defatted seed meal was found to have fat content about (0.3 and 0.1%) for jojoba and moringa respectively.

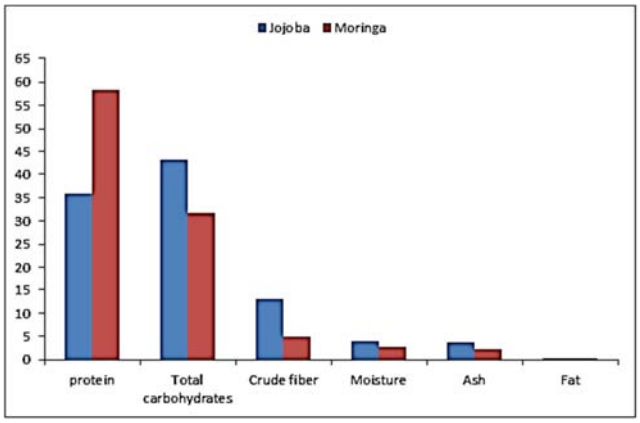

Figure 1. *Proximate composition (g/100 g) of jojoba and moringa defatted seed meal.*

The concentrate pressed meals were reduce weight from 50 to 55 % while removing simmondsin content in jojoba and pressed meals and reduced content of polyphenol in all concentrate of jojoba and moringa. The functional properties were investigated most thoroughly with the SDII concentrate because this concentrate had the lowest concentration of simmondsin, a toxic compound in jojoba, and polyphenolic compounds [32]. The concentration of simmondsin must be reduced before jojoba meal or protein concentrates can be used in food or feed products. Table (3) shows the protein yield of pressed meal concentrate of jojoba and moringa

Table 3. *Protein yield of jojoba and moringa defatted seed meal.*

Sample	Protein concentrate %	Meal concentrate (g/g)	Protein yield (g/g)
Jojoba SDI	34[d]	0.47[b]	0.159[d]
Jojoba SDII	36[c]	0.45[d]	0.162[c]
Moringa SDI	55[b]	0.50[a]	0.275[a]
Moringa SDII	58[a]	0.46[c]	0.267[b]

SDI. Water extractable protein obtained after washing the meal with methanol / acetone solution, SDII. SDI protein concentrate after washing with a methanol / HCl solution

3.2. Amino Acid Composition

The amino acid composition of jojoba and moringa defatted seed meal is presented in Table (4). Regarding essential amino acids content, both jojoba and moringa meal were found to be rich in leucine (6.24 and 7.43%, respectively) and valine (4.32 and 7.24%, respectively). Jojoba defatted seed meal showed higher isoleucine, lysine, Tyrosine and Serine contents than moringa defatted seed meal. It was also moringa meal was poor in Tryptophan. The major nonessential amino acids were observed to be glutamic acid (16.48 and 22.37%) and glycine (8.32 and 12.61%), respectively for jojoba and moringa defatted seed meal leaf.

Table 4. *Amino acids composition of defatted seed meal jojoba and M. oleifera (g/100 g protein).*

Amino acids	Jojoba	M. oleifera
Leucine	6.24	7.43
Lysine	4.68	2.32
Threonine	1.43	4.15
Tryptophan	3.69	-
Isoleucine	4.73	4.38
Valine	4.32	7.24
Methionine	1.84	1.68
Tyrosine	3.68	2.38
Cysteine	1.47	1.21
Phenylalanine	5.34	5.42
Total essential amino acids	37.42	36.21
Serine	4.93	3.72
Proline	5.34	6.43
Glycine	8.32	12.61
Alanine	4.67	6.94
Arginine	5.74	5.37
Histidine	2.71	2.94
Glutamic	16.48	22.37
Aspartic	12.73	8.63
Total non-essential amino acids	60.92	69.01

Amino acids	Jojoba	M. oleifera
Leucine	6.24	7.43
Lysine	4.68	2.32
Threonine	1.43	4.15
Tryptophan	3.69	-
Isoleucine	4.73	4.38
Valine	4.32	7.24
Methionine	1.84	1.68
Total amino acids	98.34	105.22

The quality of proteins as source of amino acids can usually be adequately assessed by comparison with the FAO/WHO [7], recommended qualified an ideal protein as one in which 36% the total residues of essential amino acids. Compared to the defatted seed meal of jojoba and moringa reported higher total essential amino acids content, and both meal had higher total essential amino acids than the FAO/WHO [7], reference pattern. These results showed that jojoba and moringa defatted seed meal could be used as a source of proteins, which contain high amount of proteins.

3.3. Chemical Analysis of Cupcakes

Table (5) and (6) presents the values of the chemical analysis of cupcakes. The moisture content found increased in the cupcake with jojoba and moringa protein concentrate with a significant difference at $p < 0.05$. Therefore that absorption of water by the protein concentrates generally increased with temperature increased, The results revealed that the water absorption increased with the increasing levels of protein concentrate. The determination of moisture is one of the most important measurements and is used in food analysis because it is related to its stability, quality and composition, and can affect the storage, packaging and processing.

The amount of protein found in the samples enriched with 75% jojoba and moringa protein had higher protein content (32 g) and the samples containing 50% jojoba and moringa protein had (8%) increasing in protein content (27 g). Also, samples with 25% protein concentrate of jojoba and moringa in the formulation of cupcakes that led to significantly increase in protein content (4%)(23 g). The values obtained in the analysis of lipids were 2.8 and 2.3 % for the samples with 75% of jojoba and moringa protein concentrate respectively and (5.3, 4.5% respectively) for samples with 50% jojoba protein and moringa protein with significant difference at $p < 0.05$ when compared with those of control sample (10.2%). Thus it can be indicate that the products have relatively low lipid.

Table 5. *Proximate composition (g/100 g) of cupcake with jojoba defatted seed meal.*

Sample	Protein	Total carbohydrates	Crude fiber	Moisture	Ash	Fat
Control	19.6[d]	52.5[a]	1.3[a]	15.4[d]	1.07[a]	10.2[a]
Jojoba 25	23.4[c]	49.8[b]	1.3[a]	16.3[c]	1.06[a]	8.1[b]
Jojoba 50	27.6[b]	46.1[c]	1.3[a]	18.7[b]	1.09[a]	5.3[c]
Jojoba 75	32.1[a]	40.5[d]	1.3[a]	22.1[a]	1.14[a]	2.8[d]

Data are presented as means ± SD (n= 3) & Means within a column with different letters are significantly different at ($P \leq 0.05$)

Table 6. *Proximate composition (g/100 g) of cupcake with M. oleifera defatted seed meal.*

Sample	Protein	Total carbohydrates	Crude fiber	Moisture	Ash	Fat
Control	19.6^{d}	52.5^{a}	1.3^{a}	15.4^{d}	1.07^{a}	10.2^{a}
Moringa 25	23.6^{c}	49.7^{b}	1.3^{a}	16.9^{c}	1.08^{a}	7.5^{b}
Moringa 50	27.8^{b}	46.2^{c}	1.3^{a}	19.1^{b}	1.14^{a}	4.5^{c}
Moringa 75	30.2^{a}	42.4^{d}	1.3^{a}	22.7^{a}	1.17^{a}	2.3^{d}

Data are presented as means ± SD (n= 3) & Means within a column with different letters are significantly different at (P≤ 0.05)

3.4. Physical Characteristics

Physical characteristics: The effect of jojoba and moringa protein concentrate on cupcake physical properties was considered, data were illustrated in Table (7). Increasing of jojoba and moringa protein substitution level increased weight property. Accordingly, increasing either jojoba and moringa protein concentrate levels could bind more water led to increasing weight. Volume of cupcakes is affected by various factors such as quality of flour, type of ingredients and processing conditions. As for volume and specific volume characteristics, significant differences ($p<0.05$) were exhibited between all cupcakes. The mean values for the volume of cupcakes indicated that the maximum value for volume was observed in control sample (107.35 cm3) followed by jojoba 25 and moringa 25 while the minimum value was observed in jojoba 75 and moringa 75. Increasing protein concentrate levels could led to decreased the volume and specific volume thinks to influence on gluten net with low strength and gas retention.

According to Table 7, the sample containing 75% concentrate protein from jojoba and moringa had the lowest specific volume. It should be noted that not only proteins have the ability to be a suitable fat replacer, but also they have the ability to strengthen the cell walls and do not allow the walls to be torn. The important point is that if we use excessive amount of additives in the formulation, it may hamper the air bubbles expansion during baking process due to the excessive increase in the strength of the their wall and therefore, not only there is no increase in volume of the final product texture, but also the texture is hard and compressed. In this study, the high levels of concentrate protein caused the same problem in low-fat cupcake.

Table 7. *Physical characteristics of cupcakes with jojoba and moringa protein concentrate.*

Sample	Weight (g)	Volume (cm^3)	Specific volume (cm^3/ g)
Control	41.18^{e}	107.35^{a}	2.61^{a}
Jojoba 25	41.94^{e}	107.04^{b}	2.55^{b}
Jojoba 50	43.47^{d}	105.73^{c}	2.43^{c}
Jojoba 75	46.72^{b}	102.92^{d}	2.20^{e}
Moringa 25	41.81^{e}	107.06^{b}	2.56^{b}
Moringa 50	44.37^{c}	105.68^{c}	2.38^{d}
Moringa 75	49.14^{a}	102.91^{d}	2.09^{f}

Means sharing the same letter in a column are not significantly different.

3.5. Sensory Characteristics

Figure 2 shows the interaction of concentrate protein of jojoba and moringa on the score given in sensory evaluation cupcakes produced samples. According to figure 2, the highest smell, taste score was given to the sample containing 25 and 50% concentrate protein of jojoba and moringa. Also, it is more likely that reduction of sweet taste in the samples containing 75% concentrate protein, which was reported by the panelists, is affected by the undesirable taste. Since samples containing 75% concentrate protein had a hard, sticky and unswallow able texture comparing to the sample containing 25 and 50% of concentrate protein, an impaired release of flavor producers happens. Therefore, if an appropriate amount of jojoba and moringa concentrate protein are used during the process of replacing oil, besides having a desirable texture, flavor producers.

The results showed that form of the samples containing 25% concentrate protein were more superior to the other samples. The panelists expressed that the unexpectedly crumb and crust color of the sample containing 75% concentrate protein, was the main reason for the low rating. It should be noted, based on the panelists" decision, the sample containing 25 and 50% protein concentrate of jojoba and moringa was better than the sample containing 75% of it, in terms of upper surface characteristics. Because according to some sensory panelists, there can be seen tiny black particles on the surface of the sample containing 75% of protein concentrate that consequently, the desirability of the final product was reduced. On the other hand, the sample containing 25% jojoba and moringa protein was more superior to the control sample due to its brighter colored surface. On the other hand, a darker appearance is seen in the samples containing high levels of concentrate protein, which was unexpectable and considered as a burnt cupcake by the panelists. Also, there was a report on abnormal surface (sticky surface) that was apparently due to too much water absorption of the cupcake samples containing high level of protein used in the formulation of low-fat cupcake.

According to the results of the evaluation of the texture of the low-fat cupcake samples, the sample containing 25 and 50% jojoba and moringa concentrate protein were given the high score on their texture qualitative properties, because this sample had the lowest amount of texture hardness than other samples. It was predicted that the sample containing 75% protein of jojoba and moringa receive the lowest scores regarding their softness and hardness.

According to results, the high overall acceptability was given to the sample containing 25 and 50% jojoba and moringa protein concentrate. Thus, since these two samples had the highest score in many parameters, it was expected that compared with other produced samples, their overall

acceptability scores be at the highest level and the panelists introduced these two samples, as the samples of low-fat cupcake with high acceptable characteristics from the perspective of the consumer.

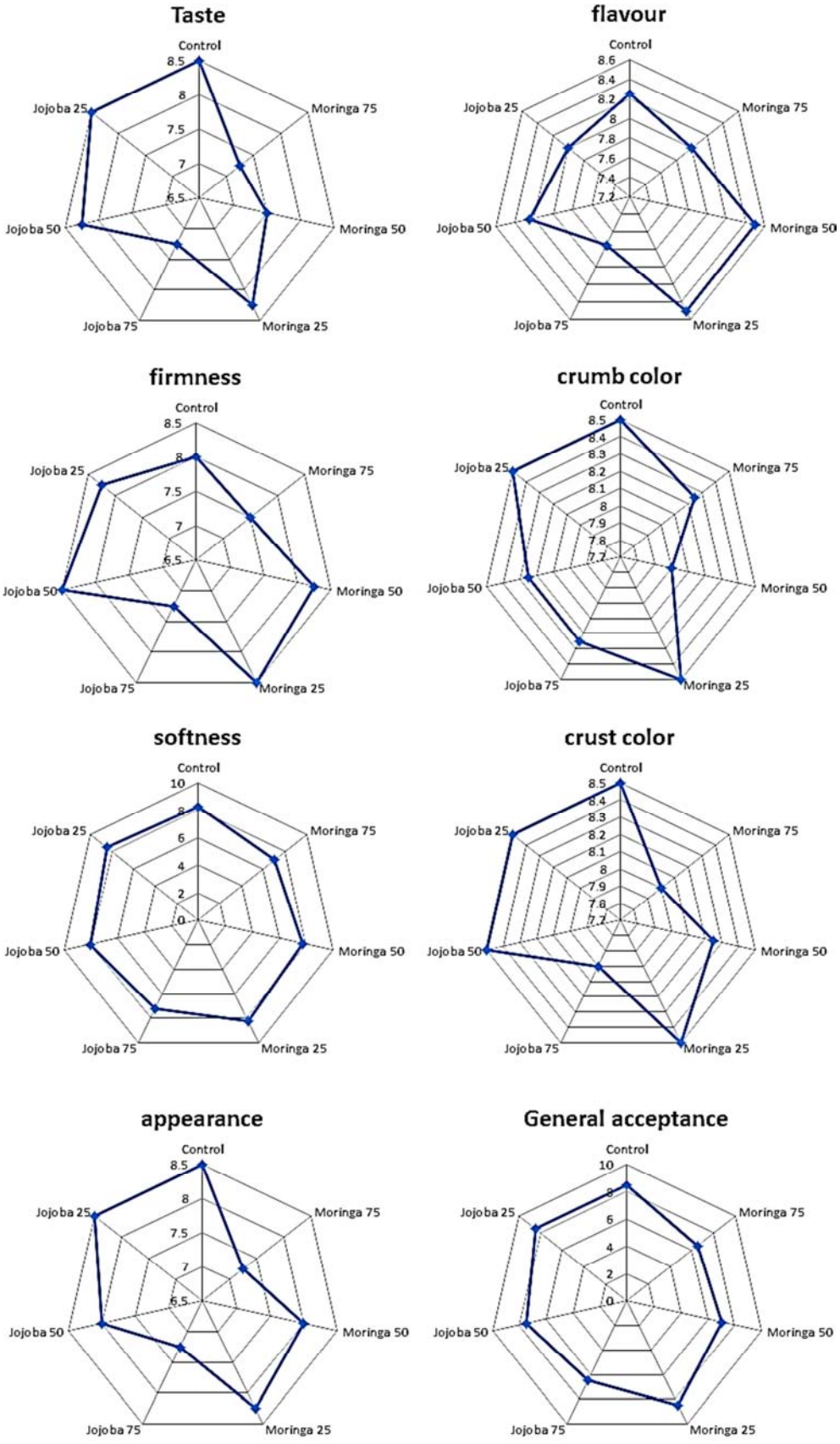

Figure 2. *Acceptance and purchase intent of cupcakes.*

4. Conclusion

The results showed that with the increase of protein concentrate of jojoba and moringa contents, the cupcake final product moisture increased and its specific volume decreased. Also, the results indicated that among produced samples, the sample containing 25 and 50% protein concentrate of jojoba and moringa had the least texture hardness. Finally, evaluating parameters like sensory properties, taste, flavor, firmness, crumb color, crust color, softness, appearance and general acceptance of the cupcake samples, we introduced the sample containing 25% protein concentrate of jojoba and moringa as the best sample. Then, the second level was acceptance in the study was content 50% of protein concentrate of jojoba and moringa. Based on results, the increase in protein concentrate contents of the sample to 75% led to reducing in quality cupcakes products. Based on the positive results of this study, the possibility to produce low-fat cupcakes with protein concentrate of jojoba and moringa with desired quantitative and qualitative properties is confirmed.

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