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Assessment Of Organoleptic, Nutritional and Antioxidant Properties Of Muffins Developed By Replacing Vegetable Oil With Grape Seed Oil

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Abstract:

Background: Grape seed oil (GSO) is gaining popularity as a functional food due to its substantial levels of hydrophilic and lipohilic constituents including phenolic compounds and phytosterols. The study aimed to assess the organoleptic, nutritional and antioxidant properties of muffins developed by replacing vegetable oil with GSO.

Methods: Product Development: Standard Muffins were prepared using 60ml of vegetable oil (VO) and Variation-I, II and III were formulated by replacing VO with GSO at 10%,15% and 20% respectively**. Organoleptic evaluation:** Organoleptic properties of the developed muffins were assessed by 30 semi-trained panelists using 9-point hedonic scale. **Proximate Analysis:** Standard AOAC methods were used to analyze total fat, protein, carbohydrates, crude fiber and moisture content. **Antioxidant Capacity Estimation:** Total Phenolic content and DPPH radical scavenging activity were determined.

Results: Organoleptic evaluation: Variation II showed high overall acceptability, with favorable scores for colour, texture, taste, aroma and overall acceptability. Proximate Analysis: Variation II had significantly lower fat (p=0.0081), protein (p=0.0046), crude fiber (p=0.0006) and moisture (p=0.0017) content compared to the standard muffins. Total phenolics and antioxidant activity: Variation II exhibited higher total phenolic content (67.15µg of gallic acid equivalent/ml) and antioxidant activity compared to the standard muffins. Free Radical Scavenging Activity: Variation II exhibited higher antioxidant activity with a lower IC_{50} value compared to the standard muffins.

Conclusion: The study focuses on the potential health benefits of incorporating GSO in muffin preparation, highlighting its antioxidant properties and nutritional profile. Adding GSO in food products like muffin can offer consumers a healthier option with enhanced antioxidant activity.

Key words: Grape Seed Oil, Vegetable Oil, Muffins, Antioxidant activity, Phenolic compounds.

1. Introduction:

Therapeutic properties of Grape seed oil (GSO) are associated with its chemical constituents including phenolic compounds, fatty acids, and vitamins (Garavaglia et al., 2016). Oil content in grape seeds range from 11.6% to 19.6%. It comprises a high concentration of linoleic acid (56.38-70.1%) a polyunsaturated fatty acid, followed by oleic acid (16.45-29.38%) a monounsaturated fatty acid (Demirtas et al., 2013; Baydar, 2007). Tocopherols, tocotrienols, phytosterols, and phenolic compounds contribute to the antioxidant properties of GSO (Demirtas et al., 2013; Shinagawa et al., 2015). These compounds have been linked to diverse health benefits, including anti-inflammatory, antiatherogenic, antimicrobial, and chemopreventive effects, as demonstrated in In-Vitro studies (Garavaglia et al., 2016). Pleasant sensory characteristics and therapeutic attributes of GSO make it a potential alternative to traditional cooking oils (Garavaglia et al., 2016). Recent research has explored the effectiveness of grape seed oil and flour as functional ingredients in muffins, delivering enhanced nutritional and antioxidant properties. (Yalcin et al., 2022; Sin-Yoon Joo et al., 2004). GSO on comparison to other cold-pressed plant oils, demonstrates moderate antioxidant activity (Siger et al., 2008). However, further research is needed to fully understand its effects on human health (Shinagawa et al., 2015).

Presently, consumers are exploring alternative plant sources to replace traditional vegetable oils (VO), prompting significant research into the extraction of oils from fruit seeds, such as grape, papaya, apricot, and apple seed oils. These oils, particularly grape seed oil (GSO), exhibit beneficial health properties. The cold-pressing method of oil extraction, which avoids heat and chemical treatment, is gaining augmentation as it preserves health-promoting components like natural antioxidants and are good source of antioxidative phenolic compounds and other phytochemicals. This method is increasingly recognized for its potential to enhance the nutritional profile of oils derived from fruit seeds, aligning with the growing consumer demand for nutritious and sustainable food sources. These findings recommend that grape seed oil can be valuable ingredients for developing functional bakery products with enhanced nutritional profiles..(Sapna Langyan et al 2022)

This study aimed to formulate muffins by partially replacing traditional vegetable oil with grape seed oil, thereafter assessing the organoleptic properties of the prepared products. The objective was to identify the most acceptable variation of the muffins based on organoleptic assessment and to perform a comprehensive analysis of the nutritional properties and antioxidant activity of both the standard muffins and the most preferred variant. This research attempts to develop healthier bakery products by utilizing the nutritional properties of grape seed oil, while retaining the sensory qualities that are key determinants for consumer acceptance.

2. Materials and Methods

The study assessed the organoleptic, nutritional, and antioxidant properties of muffins prepared with GSO as a partial replacement for vegetable oil. The study design focused on the development of muffins using both oil types, followed by assessment of organoleptic characteristics, nutritional composition, and antioxidant activity.

2.1 Product development

2.1.1 Purchase of raw materials: The raw ingredients required for development of muffins were purchased from the local departmental stores in Mysore. Urban platter pure Blue GSO Cold pressed oil 250 ml was purchased online.

2.1.2 Development and Standardization of Muffins

Table 1: Details of the Ingredients and Quantity used to Develop the (Standard Muffins, Variation-I, Variation-II and Variation-III).

Muffins	Ingredients And Quantity								Oil Replaced (%)
	Maida	Curd	Sugar	Baking powder	Baking soda	Vanilla extract	Vegetable oil	Grape seed oil	
Standard	90gm	142gm	75gm	2gm	1.5gm	6ml	60ml	-	
Variation-I							54ml	6ml	10
Variation-II							51ml	9ml	15
Variation-III							48ml	12ml	20

2.2 Organoleptic evaluation:

A 9- point hedonic scale was used to assess the organoleptic / sensory properties of muffins. Thirty semi-trained panelists were involved in the evaluation process to validate in-depth assessment of the product attributes and to identify the most acceptable variation of the muffins.

2.3 Proximate analysis

Proximate analysis (Total fat, Protein, Carbohydrates, Crude fiber, Moisture) of standard muffin and most acceptable variation were analyzed using standard AOAC procedures (2004).

2.4 Estimation of antioxidant capacity of the developed product and comparison (standard muffin vs most acceptable variation)

2.4.1 Determination of Total Phenolic Content in 96 Well Plate

Total phenolic content was determined by Folin-Ciocalteu reagent. Add 20µl of sample or standard in 96 well plates. Then add 70µl of FC reagent followed by adding 60µl of sodium carbonate and mix the content gently using pipette. Incubate for 30 min at room temperature record the absorbance at 765nm using ELISA Reader. The result was expressed as Gallic acid equivalent (%GAE) of dry weight and the experiment was conduct in triplicate analysis. (Sánchez-R., et al 2013)

2.4.2 Determination of Antioxidant Activity by DPPH Method

The antioxidant activity was determined by DPPH radical scavenging assay. Add 20µl of sample or standard, later add 140µl of DPPH to each well and mixed the content for reaction. Incubate in dark condition for 30 minutes at room temperature. Then absorbance was measured at 517nm against blank using ethanol. Analysis was carried out in a triplicate and % inhibition was calculated by using formula (Plank DW et al 2012)

$$\%\ inhibition = \frac{Absorbance\ of\ control - Absorbance\ of\ sample}{Absorbance\ of\ control} \times 100$$

2.5. Statistical Analysis

Data was analyzed using XLSTAT 2021 software. Descriptive and inferential statistical tests were performed to determine significant difference between standard muffin and most acceptable variation.

3. RESULTS AND DISCUSSION

3.1 Organoleptic/ Sensory Attributes of Muffins

Table 2: Mean Scores of Sensory Attributes of Muffins (Standard and Variations -I, II, III) assessed Using 9 Point Hedonic Scale

Variations	Colour	Texture	Taste	Aroma	Overall Acceptability
	Mean ± SD				
Standard	8.2 ± 0.7	8.2 ± 0.4	8.4 ± 0.8	8.3 ± 0.7	8.6 ± 0.4
Variation I (10%)	7.9 ± 0.4	8.0 ± 0.7	7.2 ± 1.0	7.2 ± 0.8	7.6 ± 0.9
Variation II (15%)	7.9 ± 0.5	7.8 ± 0.9	7.2 ± 0.6	7.4 ± 0.9	7.6 ± 0.8
Variation III (20%)	8.1 ± 0.6	7.6 ± 1.1	6.7 ± 1.2	7.1 ± 1.2	7.2 ± 1.0

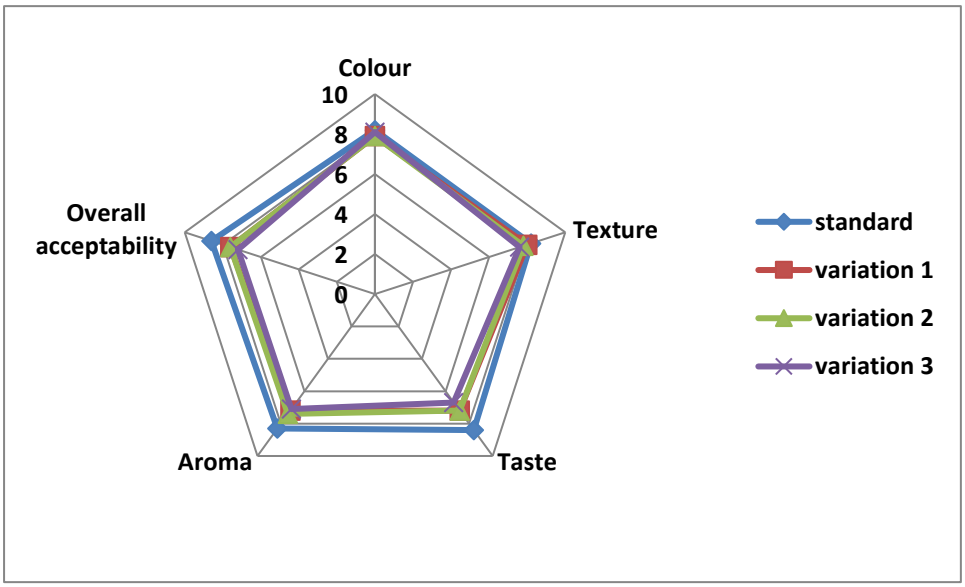


Figure 1: Radar Depicting the Mean Scores of Sensory Attributes of Muffins (Standard and Variations -I, II, III) assessed Using 9 Point Hedonic Scale.

Table 2 projects the mean scores for the sensory attributes (colour, texture, taste, aroma, and overall acceptability) assessed by the panelist using a 9- point hedonic scale. The sensory score for the above-mentioned attributes ranged from "like moderately" to "like very much", as detailed by the panelist for both standard muffins and variations (I, II, III). The standard muffin and variation- II secured mean scores of 8.6 ± 0.4 and 7.6 ± 0.8 respectively, signifying a high overall acceptability. Conversely, it is clear from the table and the radar chart that variation-III displayed lower acceptability in comparison to standard and variation-II (Figure 1).

3.2 Proximate Analysis of Muffins (Standard and Variation-II-based on the high overall acceptability)

Proximate composition of the standard and variations are presented in the table 4

Table 3: Proximate Composition of muffins Standard and Variation II per 100g

Proximate (g)	Standard	Variation-II
	Mean ± SD	
Total fat (g)	16.4±1.25	11.3±1.3
Protein (g)	5.2±0.11	4.8±0.05
Carbohydrates(g)	57.7±2.8	56.8±1.8
Crude fibre (g)	0.16 ±0.005	0.12±0.005
Moisture (%)	31.22±0.50	26.26±1.04

Proximate composition of the standard muffin was compared with variation-II, data reveals that total fat, protein, carbohydrate, crude fiber, and moisture content of standard muffins was comparatively higher than variation-II. (table 3).

Table 4: Comparison Of Proximate composition - (Standard and Variation-II-based on the high overall acceptability)

Proximate composition per 100g	Standard	Variation-II	T- Value	df	P Value
	Mean ± SD				
Total Fat (g)	16.4±1.25	11.3±1.3	4.898	4	**0.0081**
Protein(g)	5.2±0.11	4.8±0.05	5.734	4	**0.0046**
Carbohydrates(g)	57.7±2.8	56.8±1.8	0.468	4	1.9221
Crude Fiber(g)	0.16±0.005	0.12±0.005	9.798	4	**0.0006**
Moisture (%)	31.22±0.50	26.26±1.04	7.445	4	**0.0017**

Comparison of proximate composition between standard muffin and variation-II highlights a significant difference in total fat (p=0.0081), protein (p=0.0046), crude fiber (p=0.0006) and moisture (p=0.0017), suggesting that the concentration of these nutrients were significantly higher in the standard muffin. Analyzing fat content particularly, it is evident that variation-II contained significantly lower levels compared to standard muffin, which may contribute to a reduction in the overall energy content of the product (Table 5).

Total Phenolics and Antioxidant Activity.

3.3 Analysis Of Total Phenolics And Antioxidant Activity - (Standard and Variation-II-based on the high overall acceptability)

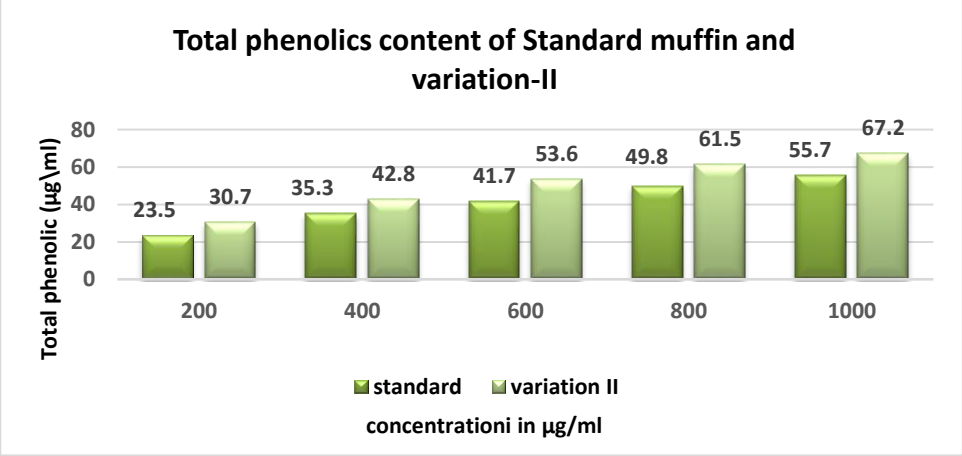


Figure 2: Total Phenolic Content of the Standard Muffin and Variation- II

The total phenolic content of the standard muffins and variation – II is presented in Fig 2. The two samples exhibited a widely varied phenolic content. Standard muffins and variation–II showed a total phenolic content ranging from 23.5±1.2 to 55.7±2.46 µg/ml and 30.7±1.9 to 67.15±2.71 µg/ml respectively with an increase in concentration. Bioactive compounds which exhibit well-documented antioxidant potential are inherent components of grape seed oil (GSO) composition (Crews et al., 2006). These bioactive compounds could potentially contribute to altering the oxidative stress state. The major compound found in GSO, as reported in the literature, is γ-tocotrienol (Crews et al., 2006).Monomeric flavanols such as catechin, epicatechin and epicatechin-3-O-gallate as well as diverse oligomer procyanidins are present at a higher concentrations in Grape seed oil.. These compounds exhibit strong antioxidant activity, leading to efficient scavenging of free radicals. (Maria E Martin *et al*., 2020), (Fernandes L *et al* .,2013) , (Mingshun Chen *et al*., 2017)

The phenolic content varied widely between the two samples. Variation – II was shown to have high phenolic content (67.15µg of gallic acid equivalent /ml). The total phenolic content was expressed as µg of gallic acid equivalent /ml using the standard curve equation y=0.1915x+0.0366, R^2= 0.9909.

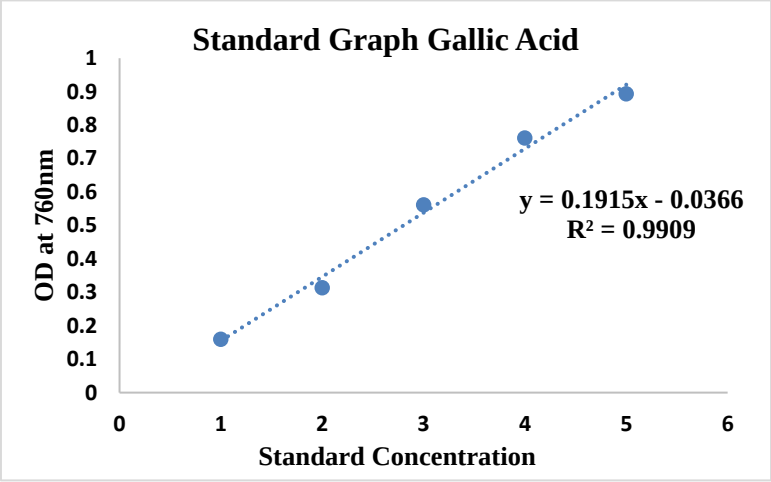
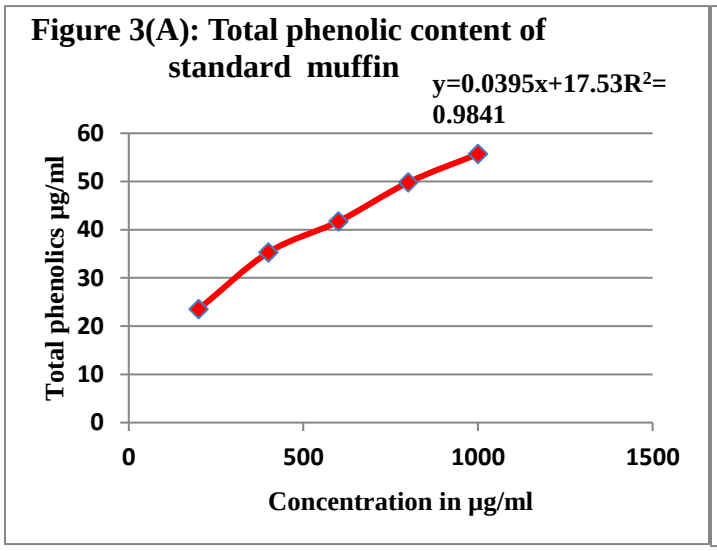


Figure:3 Standard Graph Gallic Acid



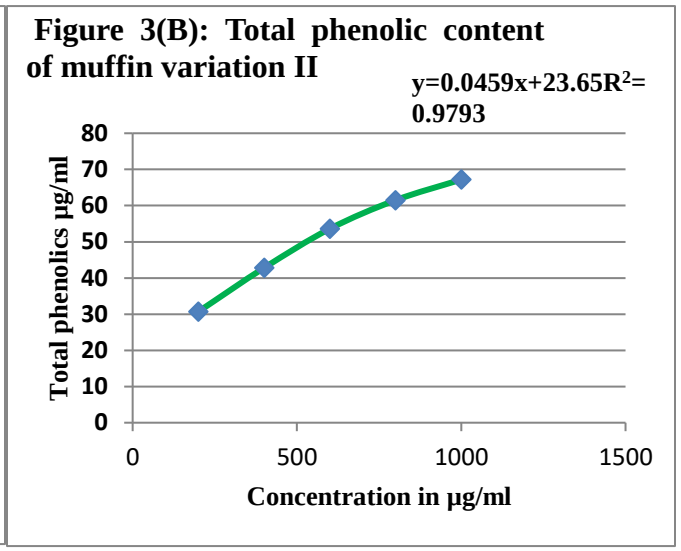


Figure 3(A): Graph Depicting the Total Phenolic Content of Standard Muffin

Figure3(B): Graph Depicting the Total Phenolic Content of Muffin Variation -II

3.4 DPPH Free Radical Scavenging Activity

Diphenyl – 1- picrylhydrazyl (DPPH) assay estimates the ability of antioxidants in food samples to reduce DPPH radicals thus the efficiency of the samples in reducing the DPPH radical depends on the amount of antioxidants available in them (Fernandes, L *et al*., 2013), (Freitas, L. S *et al*., 2008)

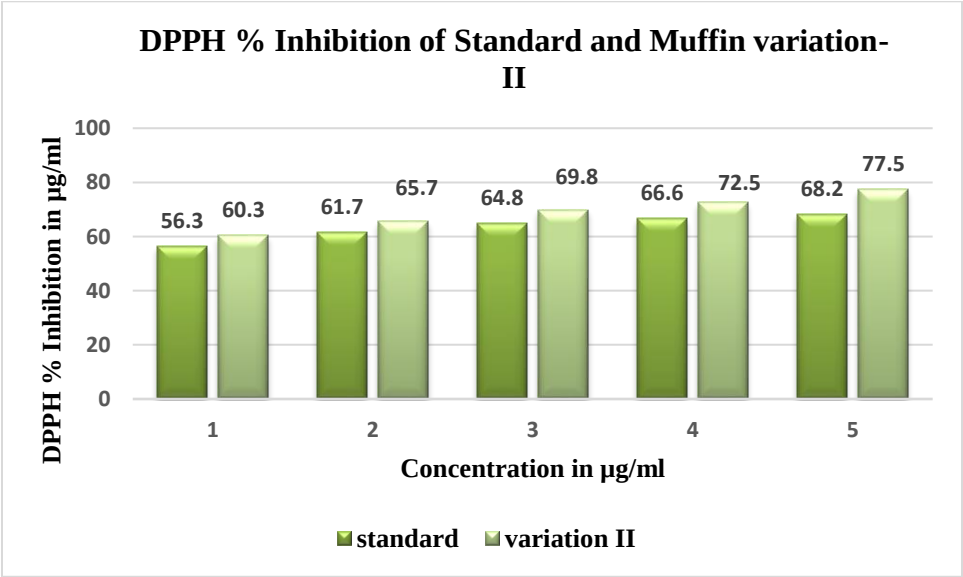


Figure 4: DPPH % Inhibition of the Standard and Muffin Variation- II

Based on the concentration the % inhibition for the standard muffin ranges from 56.3 to 68.2% µg/ml and for the variation II the % inhibition ranges from 60.3 to 77.5% µg/ml. GSO antioxidant activity is directly linked to its high concentration of vitamin E isomer, namely γ-tocotrienol. which is rarely found in other oils (Freitas, L. S *et al*., 2008),(Ky, I *et al*., 2014). O-dihydroxylic structure typical in polyphenol compounds accounts for the radical scavenging ability (García-Falcón, M.S *et al*., 2007), (Chen, J *et al*., 2020).The free radical scavenging activity of the tested samples are expressed as percentage of inhibition. A percent inhibition versus concentration curve was plotted and the concentration of the sample required for 50% inhibition was determined and represented as IC_{50} value for each of the test solution.

The DPPH radical scavenging activity is expressed as the number of equivalents of ascorbic acid the value is expressed as µg per ml ascorbic acid equivalent using the standard curve equation y= 0.8777x+9.7345, R^2 = 0.9938.

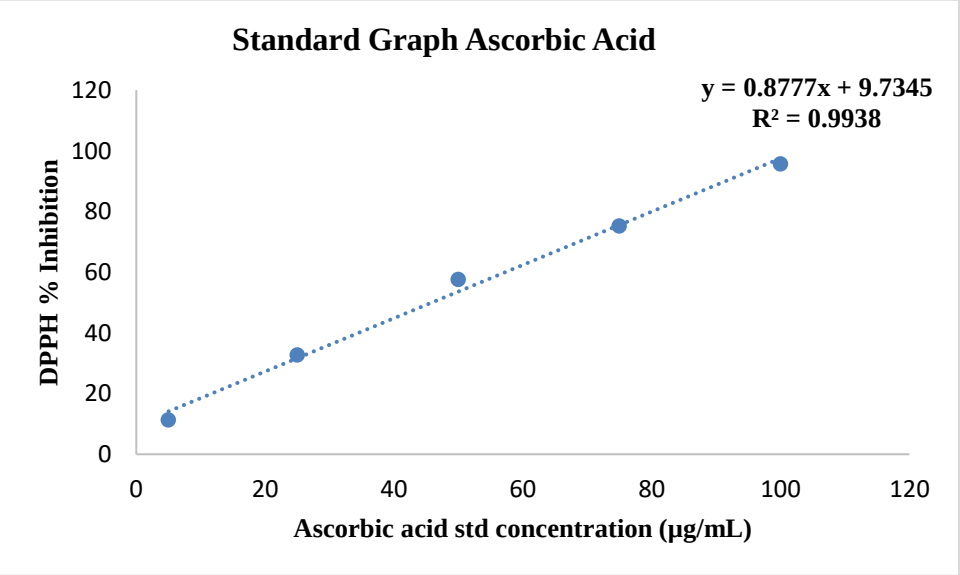
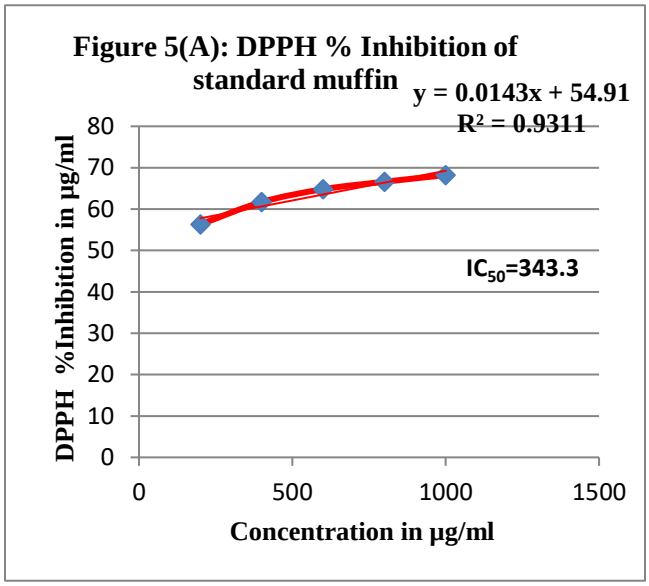


Figure No: 5 Standard Graph Ascorbic Acid



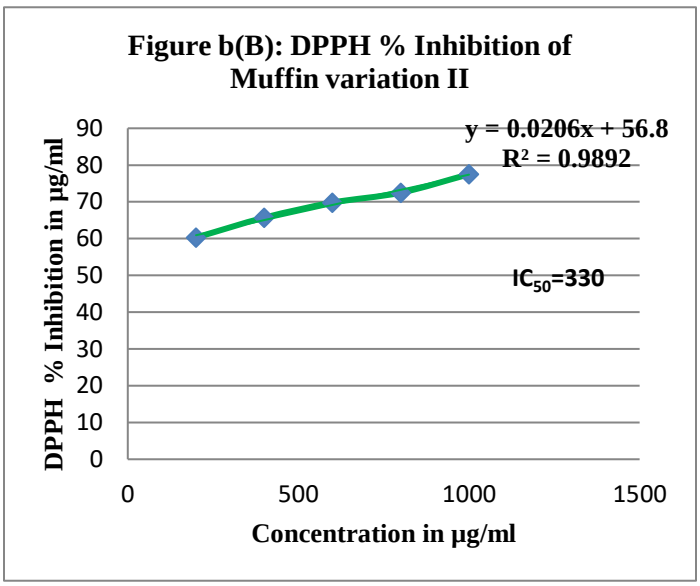


Figure 5(A): Graph Depicting the DPPH %Inhibition of Standard Muffin
Figure 5(B): Graph Depicting the DPPH %Inhibition of Variation-II Muffin

Free Radical Scavenging Activity IC_{50} µg/ml of the Standard Muffin and Acceptable Variation (Variation – II)

Standard and variation II shows the free radical scavenging activity with IC_{50} value. The standard muffin IC_{50} value was 343.3µg/ml and IC_{50} value of acceptable variation (variation –II) was 330µg/ml. IC_{50} value of variation II muffins was low indicating a higher antioxidant capacity than the standard muffin. The results can also be correlated with the phenolic content where variation –II showed concentrations dependent increase in phenolic content when compared to standard.

Comparison of Antioxidant Assays of Standard Muffin and Acceptable Variation (Variation – II)

Table 5: Comparisons of Antioxidant Assays of Standard Muffin and Acceptable Variation (Variation – II)

Antioxidant Assay(µg/ml)	Standard Mean±SD	Variation II Mean±SD	t Test	df	p Value

Total Phenolics	55.67±2.468	67.15±2.713	5.421	4	0.0056
DPPH	68.02±4.43	77.54±0.51	-3.698	4	0.0209

The means of the two samples were statistically analyzed to find a significant difference in various antioxidant assays such as total phenolics and DPPH activity. Table 5 clearly indicates that Variation II had significantly higher levels of total phenolics (p=0.0056) and DPPH activity (p=0.0209).

4.SUMMARY

Grapeseed oil, contributes a high amount of unsaturated fatty acids (85~90%) and performs promising function as an antioxidant, blood clotting, and anticancer agent. In this study, Muffins were developed by replacing VO with GSO at 10% (variation I), 15% (variation II) and 20% (variation III) along with standard muffin by using VO. Sensory evaluation of the prepared products signifies that variation-II had high acceptability when compared to standard, variation I and III. The proximate composition comparison of standard and variation II indicates a significantly higher amounts of protein (p=0.0046), fat (p=0.0081), crude fiber (0.0006) and moisture (p=0.0017) in standard muffin. Total phenolics and DPPH scavenging activity of the developed products, standard and variation II was compared. The total phenolic content (p=0.0056) and DPPH radical scavenging activity (p=0.0209) of muffin variation II was significantly higher than standard muffin.

5. CONCLUSION

GSO is a by-product of winemaking industry, with exceptional health benefits. Although the nutritional and nutraceutical value of GSO is well recognized, attempts to explore their inclusion as value-added compound potentially will be promising in health promotion. GSO is plant-based, heart- healthy cooking oil, a good source of vitamin E, phenolic antioxidants, and medium-chain saturated fatty acids. It contains low total saturated fats than vegetable oils. It is neutral in flavour and interchangeable/replaced with vegetable oil. However, GSO is expensive; hence its potential benefits can be wielded by using them in comparatively lesser amounts as a value-added source in products like baking, salad dressing and mayonnaise to increase the health benefits. Our study findings reveals that use of GSO as a vegetable oil replacer in small amounts is beneficial as it imparts to excellent nutritional value and high antioxidant activity of the developed muffins.

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