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Investigating the therapeutic power of rosemary oil extraction for the reduction in body mass index and waist-to-hip ration for weight management in obese female subjects

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Abstract: Carnosic acids and other bioactive substances in rosemary essential oil help regulate weight by decreasing dietary fat absorption. This study examined how 380mg of encapsulated rosemary oil affected body mass index and waist-to-hip ratio. 40 obese women were studied. The eight-week study. Before and after the study, BMI and WHR were measured. This study used two-sample t-tests. This study found that rosemary oil was a light-yellow liquid with a distinct smell and soluble in polar solvents like alcohol. Its relative density was 0.91±0.18, the refractive index was 1.39±0.06, pH was 6.01±0.31, and optical rotation was -4.87°. It contained moisture content (9.27±1.38)%, total ash (6.98±0.18)%, water soluble ash (4.01±0.06)%, and acid soluble ash (1.89±0.31)%. Total phenolic content (TPC) was 123.74±0.02mg GAE/g and total flavonoid content (TFC) was 57.21±0.11mg QE/g. Results showed a significant reduction in body mass index in treatment groups. The treatment group showed a reduction in body mass index from 37.29±9.86 to 35.21±18.74. However, the control group showed no change. Results showed a significant reduction in the waist-to-hip ratio from 0.97±0.03 to 0.91±0.04. However, the control group showed a slight increase in the waist-to-hip ratio over the period. Thus, rosemary oil can be useful in the management of obesity.

Keywords: Rosemary oil, *Rosemarinus officinalis,* weight management, waist-to-hip ratio, body mass index, phytochemical determination, total ash, soluble ash, total flavonoids, total phenolics.

INTRODUCTION

Obesity is prevalent around the globe as an epidemic and has carved a path for several chronic diseases like cardiovascular diseases, hyperlipidemia, diabetes and nonalcoholic fatty liver diseases. It is the leading cause of stroke and joint pains. Obesity is a risk factor for cancer pathogenesis. Around 90% of people suffering from type II diabetes are either obese or overweight (Obesity & High, 2019). Obesity results in insulin resistance in type II diabetes. Obesity is more common in people following western style diets, high fat and high carbohydrate diets. Physical inactivity is another contributing risk factor in the progression of obesity. Many drug and natural therapies are under practice and under research to combat obesity (Micić *et al*., 2021). Functional foods are very effective to reduce obesity and body mass index. Many scientists are investigating the therapeutic potential of these functional foods that can be useful in reducing the parameters of obesity (Banik & Naher, 2020).

Rosemary oil is among the well-known essential oils that carry tremendous functional properties which are useful in lowering oxidative stress and inflammations and are used for commercial purposes in the cosmetic industry and skin care products (Vasdev *et al*., 2022). Rosemary oil has also shown exceptional properties in the food industry as a natural preservative and in the nutraceutical industry as an oral supplement. Rosemary oil also possesses hepatoprotective properties (Zhao *et al*., 2015). The Food and Drug Administration (FDA) has recognized rosemary oil as safe. Rosemary oil contains many phytochemicals with medicinal properties. It fundamentally contains rosmarinic acid, carnosic acid, carnosol and rosmarol. These compounds not only possess antioxidant properties but also improve metabolic functions in the body. These compounds decrease dietary fat absorption and decrease pancreatic lipase activity. Pancreatic lipase is the enzyme that mainly helps in fat digestion in the small intestine. Thus, rosemary oil is helpful in the management of obesity (Zhao *et al*., 2015).

This study has investigated the therapeutic properties of rosemary oil in obese female subjects. Parameters including body mass index and waist-to-hip ratio were measured. This study has investigated the chemical characterization including proximate analysis, physicochemical properties and phytochemical determination of rosemary oil.

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MATERIALS AND METHODS

Collection and preparation of raw material

Commercially available encapsulated rosemary oil was purchased from Amazon's online store. The capsules contained 90% carnosic acid with 380mg of rosemary oil in each capsule. The capsules were gelatin free and were stored at room temperature.

Chemical characterization of rosemary oil

Proximate Analysis of Rosemary oil

Rosemary was analyzed for the following proximate profile including moisture content, total ash, water-soluble ash, and acid-soluble ash, determined according to the AOAC method (Akpabio *et al*., 2012).

Physicochemical properties

Physicochemical properties are beneficial in determining the quality of essential oil, which include determination of relative density, refractive index, pH, odor, color, solubility, optical rotation and appearance (Amri *et al*., 2013).

Phytochemical characteristics of rosemary oil

Phytochemical analysis of rosemary was undertaken for the determination of total phenolic content (TPC) and total flavonoid content (TFC) in methanol extraction. The amount of TPC and TFC was measured in mg of gallic acid equivalent per g of sample and mg of catechin equivalent per mof sample respectively mg gallic acid equivalent per g of the sample and mg of quercetin equivalents (QE) per g of the sample (Kassahun & Feleke, 2019).

Investigating the therapeutic effect of rosemary oil on obesity parameters

Selection of subjects

40 female subjects with body mass index >30 was enrolled in this study.

Exclusion criteria

The following were not included in the study.

- Female subjects with normal BMI range
- Female subjects with BMI <30
- Subjects with chronic conditions like cancer, renal and cardiac diseases
- Pregnant and lactating women
- Obese and overweight men

Inclusion criteria

The body mass index (BMI) of participants was calculated by measuring the weight in kilograms and height in meters. BMI was measured by dividing the weight in kilograms by the square of height in meters. All subjects with BMI >30 were enrolled in the study.

Study duration and study design

The study was conducted for six weeks.

Treatment groups and treatment plan

Subjects were divided into two groups i.e., the control group and the treatment group.

Table 1: Treatment groups and treatment plan

Groups	Title	Treatment
G_0	Control group	No treatment
G_1	Treatment group	Rosemary oil encapsulated dose 380mg/ day.

Diet of subjects

All subjects were given 1800 kilocalories according to acceptable distribution macronutrient ranges (ADMR) (Lee *et al*., 2015).

- carbohydrates?55-70%
- proteins 7-20%
- fats 15-25%

Parameters

The following parameters were measured before and after the trial.

- BMI
- waist-to-hip ratio
- skin fold measurement

Ethical approval

Ethical approval has been taken from the Biosafety Committee of the Institute.

STATISTICAL ANALYSIS

Descriptive statistical analysis using the two-sample t-test under a Completely Randomized Design (CRD) was carried out to investigate the level of significance ($p<0.05$). Results are shown as mean± S.D. All statistical analyses are done with IBM SPSS Statistics 20.

RESULTS

This research study has been designed to determine chemical composition, phytochemical content, mineral contents, changes in BMI, skin fold measurement, and a waist-to-hip ratio of obese female subjects.

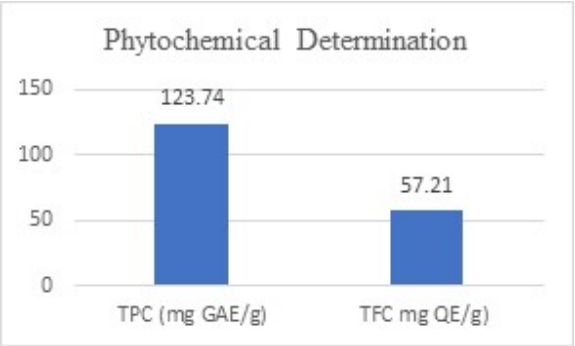

Fig. 1: Phytochemical determination in rosemary oil.

Proximate analysis of rosemary oil

Rosemary oil was oil investigated for varied characteristics, such as total ash, water-soluble ash, and acid-soluble ash as depicted in Table II. It contained moisture content (9.27±1.38)%, total ash (6.98±0.18)%, water soluble ash (4.01±0.06)%, and acid soluble ash (1.89±0.31)%.

Physicochemical characteristics of rosemary oil

Results are shown for physicochemical properties including relative density, refractive index, pH, odor, color, solubility, optical rotation and appearance. Rosemary oil is a light yellowish liquid, with a characteristic odor and it is soluble in a polar solvent like alcohol. Its relative density is 0.91±0.18, the refractive index is 1.39±0.06, pH is 6.01±0.31 and optical rotation is -4.87^{o}.

Table 2: Mean ± S.D for proximate values of rosemary oil.

Proximate analysis	Composition (%)
Moisture	9.27±1.38
Total Ash	6.98±0.18
Water soluble ash	4.01±0.06
Acid soluble ash	1.89±0.31

Table 3: Mean ± S.D for physicochemical properties of rosemary oil

Color	Light yellowish
Solubility	Soluble in polar solvent alcohol
Appearance	Colorless liquid
Relative Density	0.91±0.18
Reflective Index	1.39±0.06
pH	6.01±0.31
Optical Rotation	-4.87^{o}

Table 4: Mean ± S.D for changes in BMI.

Duration	T_O	T_1
0 week	38.91±10.25	37.29±9.86
8th week	38.00±10.87	35.21±18.74

T_0 = No Treatment, T_1=380 mg encapsulated rosemary oil. Results were taken significant at $p<0.05$.

Table 5: Mean ± S.D for changes in waist to hip ratio.

Duration	T_O	T_1
0 week	0.95±0.02	0.97±0.03
8th week	0.96±0.03	0.91±0.04

T_0 = No Treatment, T_1=380 mg of encapsulated rosemary oil. Results were taken significant at $p<0.05$.

Phytochemical characteristics of rosemary oil

Rosemary oil carries a significant amount of TPC and TFC as depicted in fig. 1. TPC was 123.74±0.02mg GAE/g and TFC was 57.21±0.11mg QE/g (Khademi Doozakhdarreh *et al*., 2022).

Investigating the therapeutic effect of rosemary oil on obesity parameters

40 obese female participants were enrolled in the study and the treatment group was given 380mg/d of encapsulated rosemary oil. Participants of the control group (T_0) were given no treatment. BMI and waist-to-hip ratio were measured before and after the trial.

Changes in BMI

Results showed a significant reduction in BMI in treatment groups. Treatment showed a reduction in BMI from 37.29±9.86 to 35.21±18.74 when given encapsulated dose of rosemary oil of 380mg. However, the control group showed no change.

Changes in waist-to-hip ratio

Results showed a significant reduction in the waist-to-hip ratio treatment groups. Group-I showed a reduction in the waist-to-hip ratio from 0.97±0.03 to 0.91±0.04. However, the control group showed a slight increase in the waist-to-hip ratio over the period.

DISCUSSION

The study was designed to investigate the therapeutic effect of rosemary oil in the management of obesity parameters including BMI and waist-to-hip ratio. Rich in antioxidants and a natural anti-inflammatory, rosemary essential oil help promotes weight loss by significantly reducing cortisol, which increases during times of high stress and anxiety. Rosemary has significant antimicrobial, anti-inflammatory, anti-oxidant, anti-apoptotic, anti-tumorigenic, antinociceptive, and neuroprotective properties. Furthermore, it shows important clinical effects on mood, learning, memory, pain, anxiety, and sleep. Ash content, moisture, and physicochemical properties of rosemary oil were also investigated (Khademi Doozakhdarreh *et al.*, 2022).

The study also determined the phytochemical content of rosemary oil. The study measured the total ash content, water, and acid-soluble ash of rosemary oil. These values were slightly higher than the values found in the literature, which can be due to environmental conditions and the source of rosemary oil (Fernandes et al., 2014). Physicochemical properties were determined, which reported slight differences in color, refractive index, and optical rotation from the previous study but these differences were very minor (Kassahun & Feleke, 2019). Rosemary oil showed the presence of a significant amount of phytochemical contents thus rosemary oil is helpful in reducing oxidative stress (Khademi Doozakhdarreh *et al.*, 2022).

The study reported a reduction in BMI and waist-to-hip ratio in all participants of the treatment group who were given 380 mg/d of encapsulated rosemary oil. Reduction in BMI is a direct indicator of weight reduction. These findings were also observed in an animal study in which mice were given rosemary oil with a high-fat diet. That study also reported a reduction in the weight of mice (Zhao *et al*., 2015).

Another study also reported the same results that showed a reduction in inflammation and weight in response to rosemary oil (Juhás *et al*., 2009). Thus, rosemary oil is useful in the management of weight. The polyphenols in rosemary tea can help to boost metabolism and promote fat burning. This Herb can also help to suppress appetite, making it easier to stick to a healthy diet. A cup of rosemary tea before meals may help you eat less and control your portions better throughout the day.

In fact, research in mice demonstrates that by clearing out estrogen, rosemary helps decreases the hormone's ability to cause cancer, and a study in Oncology Reports showed that rosemary extract slowed the spread of human leukemia and breast carcinoma cells.

CONCLUSION

Rosemary oil is an essential oil with exceptional nutraceutical properties and contains a wide range of phytochemicals. Rosemary essential oil can reduce the absorption of dietary fat and the activity of pancreatic lipase, thus, reducing the availability of fat to the body. An encapsulated dose of 380mg/d showed a significant reduction in the waist-to-hip ratio, BMI and weight. Rosemary oil contains a generous number of phytochemicals that help reduce obesity-induced inflammations and insulin resistance. Thus, it can also help lower the risk of obesity-induced chronic complications.

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