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# INCORPORATION OF POLYHERBAL FORMULATION INTO THERAPEUTIC COOKIES FOR THE MANAGING DISORDERS OF CARBOHYDRATE AND LIPID DYSREGULATION

## Running Tittle: Polyherbal Cookies for Metabolic Syndrome Management

**FAUZIA BANO[1], SEEMA KANOJIA[2], ARVIND K. SRIVASTAVA[3]***

[1,2] *Department of Food and Nutrition, Era University, Sarfarazganj, Lucknow 226003*

[3*]*Corresponding Author: Professor, Department of Food and Nutrition, Era University, Sarfarazganj, Lucknow 226003* fauzia0710@gmail.com

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**Abstract**

The increasing consumer demand for health-promoting foods has intensified research on functional ingredients with potential nutraceutical benefits. In the present investigation, a polyherbal formulation (PF) was incorporated into cookies to develop a value-added functional food with enhanced nutritional and therapeutic attributes. The PF comprised *Olea europaea* (leaves), *Momordica charantia* (fruit), *Enicostemma littorale* (leaves), *Gymnema sylvestre* (leaves), *Cinnamomum zeylanicum* (bark), *Garcinia indica* (fruit), *Hibiscus rosa-sinensis* (flower), and *Emblica officinalis* (fruit), selected based on their documented hypoglycemic and hypolipidemic properties. The developed formulations were subjected to proximate composition analysis following standard protocols, alongside sensory evaluation using a hedonic scale. Incorporation of PF resulted in the enhancement in protein and dietary fiber content, accompanied by a reduction in crude fat and available carbohydrate fractions. These compositional modifications indicate improved nutritional quality. Sensory attributes remained within acceptable limits across optimized formulations, supporting consumer acceptability.

Overall, the findings substantiate the feasibility of incorporating polyherbal blends into bakery products as a strategy for developing functional foods with potential applications in the management of metabolic disorders. Such formulations also provide a platform for the integration of traditional phyto-therapeutic knowledge into modern food systems.

## 1. Introduction

The industry for herbal medicines has grown rapidly during the past few decades. Ayurvedic drug formulation is based on two principles: both the usage of a single drug and multiple drugs. Last is referred to as a polyherbal composition [Sane, 2002; Abraham, 2013]. For this study polyherbal formulation was prepared by using eight different herbs which has similar pharmological and therapeutic significance namely: *Olea europaea* (leaves), *Momordica charantia* (fruit), *Enicostemma littorale* (leaves), *Gymnema sylvestre* (leaves), *Cinnamomum zeylanicum* (bark), *Garcinia indica* (fruit), *Hibiscus rosasinensis* (flower), *Emblica officinalis* (fruit). 1**. *Olea europaea*** – Leaves of Olive are used for study as they have Antioxidant, anti-carcinogenic, anti-inflammatory, antibacterial, antihypertensive, anti-dyslipidemic,

laxative, and anti-platelet activities [Drira et al.,2011; Malliou et al.,2018; Manna et al.,2004]. 2. ***Momordica charantia*** - *M. charantia* fruit cause decrease in blood sugar and serum cholesterols and also shows antihypertensive activities [Lotlikar et al., 1966; Singh et al., 1989]. 3. ***Enicostemma littorale*** - Leaves cause lowering of fasting blood glucose, glycosylated haemoglobin (HbA1c), TC, triglyceride, LDL and also intensify the plasma insulin, HDL levels [Upadhyay et al.,2004]. 4. ***Gymnema sylvestre*** (Gurmar) – Leaves shows hypo3glycemic activities in various studies [Kang et al., 2012]. 5. ***Cinnamomum zeylanicum*** (Cinnamon) - *Cinnamomum zeylanicum* have numerous beneficial health effects such as anti-inflammatory properties, anti-microbial activity, reducing cardiovascular disease, boosting cognitive function [Chericoni et al., 2005.] 6. ***Garcinia indica*** (Kokum) - Anti-bacterial activity, Antifungal activity, Gastro protective effect, Neuro protection, Anti-diabetic effect, Cardio protective effect and Anti-obesity activity [Liao et al., 2005; Xu et al., 2004]. *7.* ***Hibiscus rosasinensis*** (Rose mallow) - Anti-inflammatory, Antipyretic, Antibacterial, Anti-tumor and Anti-diabetic [Sachdewa., 2003] 8. ***Emblica officinalis*** (Indian gooseberry) -Anti-atherogenic, Adaptogenic, Cardio, Gastro, Nephro, Neuro, Protective and Anticancer properties [Srivasuki., 2012].

Products that have been enriched with a significant amount of medicinal plants and possessing sufficient organoleptic properties could enough to boost product quality and make amends for the absence of nutritive and functional elements. Therefore, for this study therapeutic cookies were prepared by incorporation of polyherbal formulation to enhance their organoleptic properties as well as therapeutic value.

## 2. Material and Methods

2.1. **Materials**- Whole wheat flour, butter [Amul], powdered sugar, full fat milk, baking powder, table salt, Stevia leaves, Olea europaea leaves (OL), Momordica charantia fruit (MF), Enicostemma littorale leaves (EL), Gymnema sylvestre leaves (GL), Cinnamomum zeylanicum bark (CB), Garcinia indica fruit (GF), Hibiscus rosasinensis flower (HF), Emblica officinalis fruit (EF) all ingredients were purchased from local market of Lucknow.

### 2.2 Methods-

#### 2.2.1. Preparation of polyherbal formulation (PF)

Procured crude powder of OL, MF, EL, GL, CB, GF, HF and EF were weighed by using electronic analytical balance (Kerro series P7) in different amount on the basis of previous researches and then mix together. Prepared dried powder was kept at room temperature in sealed air tight container.

#### 2.2.2. Procurement of raw material for preparation therapeutic cookies

Whole wheat flour, butter [Amul], powdered sugar, full fat milk [Amul], baking powder, table salt, Stevia leaves were procured from the local market of Lucknow.

#### 2.2.3. Preparation of therapeutic cookies

Six formulations of cookies were prepared using whole wheat flour (50 g) with varying levels of polyherbal formulation (PF), while other ingredients remained constant. Sugar was replaced with stevia leaves in all fortified samples. The control (T0) contained 0% PF, while T1, T2, T3, T4, T5, and T6 contained 0.2%, 0.4%, 0.6%, 2.0%, 4.0%, and 6.0% PF, respectively. For preparation, butter and powdered sugar were creamed using an electric hand blender for 2–3 minutes until light and fluffy. Dry ingredients were incorporated using a cut-and-fold method

to form dough, which was then refrigerated for 15 minutes. The dough was rolled, cut into desired shapes, and placed on a butter paper-lined baking tray. Cookies were baked in a preheated oven at 160°C for 20 minutes, cooled, and stored in airtight containers for further analysis.

2.2.4. **Organoleptic evaluation of therapeutic cookies** - Organoleptic or sensory evaluation was done by using 09-point hedonic rating scale. The most widely used scale for measuring food acceptability is the 9-point hedonic scale. This equal-interval property helps justify the practice of analyzing the responses by assigning successive integer values (1, 2, 3, … up to 9) to the scale points and testing differences in average acceptability using parametric statistics [Kroll, et al; 1990; Mubnoz,et al ;2007].

2.2.5. **Proximate Composition of therapeutic cookies** - Proximate composition (moisture content, ash, fat and fiber content) was determined by using different methods (AOAC, 2000s) [AOAC., 2000; Amin., 2016]

2.2.6. **Statistical analysis –** All results were expressed as the mean ± standard deviation (S.D). Data were analysed using one-way variance analysis (ANOVA), using SPSS, version 22.

## 3. Results and Discussion-

### 3.1 Preparation of polyherbal formulation-

Crude powder of selected herbs was mixed in different proportions. OL (2.5%), MF (10.0%), EL (12.5%), GL (12.5%), CB (10.0%), GF (20.0%), HF (12.5%) and EF (20.0%).

Table 1. Composition of polyherbal formulation

| Crude powder of herbs | Amount (Per 100 gm) | Amount in% |
|---|---|---|
| **Olive leaves (OL)** | 2.50 gm | 2.5 % |
| **Bitter gourd fruit (MF)** | 10.00 gm | 10 % |
| **Cheriata leaves (EL)** | 12.50 gm | 12.5 % |
| **Gurmar leaves (GL)** | 12.50 gm | 12.5 % |
| **Cinnamon bark (CB)** | 10.00 gm | 10 % |
| **Kokum fruit (GF)** | 20.00 gm | 20 % |
| **Hibiscus flower (HF)** | 12.50 gm | 12.5 % |
| **Amla fruit (EF)** | 20.00 gm | 20 % |

### Composition of Therapeutic Cookies-

Ingredients of therapeutic cookies are mentioned in Table (3). From the obtained results, control cookies (T0) were contained 0% of PF, cookies having different amount of PF were coded on the basis of percentage of PF in cookie i.e. T1 having 0.2 % of PF, T2 with 0.4% of, T3 with 0.6%, T4 having 2.0% of PF, T5 with 4.0% of PF and T6 with 6.0% of PF.

| Sample | Ingredients | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Whole wheat flour (gm)** | **Butter [Amul] (gm)** | **Table Sugar (gm)** | **Stevia Leaves (gm)** | **Baking Powder (gm)** | **Table salt** | **Full fat milk** | **Polyherbal Formulation** |
| | | | | **(gm)** | | | **(ml)** | **n [PF] (gm)** |
| T0 | 50.00 | 30.00 | 20.00 | - | 1 pinch | 1 pinch | - | - |
| T1 | 49.90 | 20.00 | - | 10.00 | 1 pinch | 1 pinch | 10.0 | 0.10 |
| T2 | 49.80 | 20.00 | - | 10.00 | 1 pinch | 1 pinch | 10.0 | 0.20 |
| T3 | 49.70 | 20.00 | - | 10.00 | 1 pinch | 1 pinch | 10.0 | 0.30 |
| T4 | 49.00 | 20.00 | - | 10.00 | 1 pinch | 1 pinch | 10.0 | 1.0 |
| T5 | 48.00 | 20.00 | - | 10.00 | 1 pinch | 1 pinch | 10.0 | 2.0 |
| T6 | 47.00 | 20.00 | - | 10.00 | 1 pinch | 1 pinch | 10.0 | 3.0 |

Amount of fat (butter) was reduced in fortified cookies (20gm) as compare to control cookies (30 gm), table sugar (20gm) is replaced by Stevia leaves (10 gm) in cookies with PF (T1, T2….T6). Full fat milk (10ml) was added for the purpose of binding of dough. Other ingredients were remain constant in control and fortified cookies.

### 3.2 **Sensory Characteristics of Therapeutic Cookies-**

The data in Table (4) showed the results of one-way analysis of variance of sensory characteristics as follows:

**Color:** There are statistically significant differences among the control group and group having 6% of PF in which the value of F is (5.15) and sig (< 0.001), and the value of R2 is (0.269).

**Texture:** There are statistically significant differences among the control group and group having 4% of PF (T5) and the group having 6% of PF (T6) in which the value of F is (5.82) and sig (< 0.001), and the value of R2 is (0.293).

**Taste** – There is no statistically significant differences among the control group and group having 0.2% of PF (T1) while there are statistically differences in taste of the other group i.e.T2, T3, T4, T5, T6 having 0.4%, 0.6%, 2.0%, 4.0%, 6.0% of PF respectively in which the value of F is (63.76) and sig (< 0.001), and the value of R2 is (0.820).

**Table 4. Sensory evaluations of Therapeutic cookies-**

| **Sample** | **Analyzed Parameters** | | | | |
|---|---|---|---|---|---|
| **Code** | **Color** | **Texture** | **Flavor** | **Taste** | **Overall** |
| | | | | | **Acceptability** |
| **T0** | 8.69 ± 0.480 | 8.69 ± 0.48 | 8.46 ± 0.77 | 8.46 ± 0.77 | 8.46 ± 0.77 |
| **T1** | **8.23 ± 0.95** | **8.38 ± 0.76** | **8.00 ± 0.81** | **8.00 ± 0.81** | **8.07 ± 0.75** |

| | | | | | |
|---|---|---|---|---|---|
| **T2** | 7.92 ± 0.95 | 8.07 ± 1.03 | 7.07 ± 1.03 | 6.84 ± 1.21 | 7.38 ± 0.65 |
| **T3** | 7.76 ± 1.36 | 7.84 ± 0.98 | 6.76 ± 0.83 | 6.07 ± 1.32 | 6.92 ± 0.75 |
| **T4** | 7.76 ± 0.72 | 7.76 ± 0.75 | 5.07 ± 1.18 | 3.69 ± 1.31 | 5.38 ± 1.04 |
| **T5** | 7.46 ± 1.05 | 7.38 ± 1.04 | 4.00 ± 1.87 | 3.15 ± 1.34 | 4.61 ± 1.70 |
| **T6** | 6.69 ± 1.25 | 6.76 ± 1.36 | 3.00 ± 1.87 | 2.15 ± 0.89 | 3.07 ± 1.84 |
| **p -value** | **0.0001*** | **0.0001*** | **0.0001*** | **0.0001*** | **0.0001*** |
| **F- value** | 5.15 | 5.82 | 33.97 | 63.76 | 37.04 |
| **$R^2$** | 0.269 | 0.293 | 0.708 | 0.820 | 0.725 |

***p- value < 0.05 is considered as statistically significant**

**Flavour** - There are statistically significant differences among the control group and group having 0.6% of PF (T3), group with 2% of PF (T4), having 4% of PF (T5) and the group having 6% of PF (T6) in which the value of F is (33.97) and sig (< 0.001), and the value of R2 is (0.708). There are least significant difference (LSD) in the flavor of the group with 0.2% of PF (T1) and group having 0.4% of PF (T2) as compare to control group.

**Overall acceptability-** There are statistically significant differences among the control group and group having 0.6% of PF (T3), group with 2% of PF (T4), having 4% of PF (T5) and the group having 6% of PF (T6) in which the value of F is (33.97) and sig (< 0.001), and the value of R2 is (0.708). There are least significant difference (LSD) in the overall acceptability of the group with 0.2% of PF (T1) and group having 0.4% of PF (T2) as compare to control group. So, these results confirmed that the use of polyherbal formulation (PF) do not affect the **sensory qualities of the cookies with 0.2% and 0.4% of PF.**

**3.4 Proximate Composition of Therapeutic Cookies** - Comparative values of proximate composition of therapeutic cookies which are accepted in sensory evaluation and control cookies are presented in Table (5).

Table: 5 - **Proximate Composition of Therapeutic Cookies**

| **Nutrients [ Per 100 gm]** | **T0** | **T1 [ACCEPTED]** |
|---|---|---|
| **Total Energy (kcal)** | 521.9 | 482.84 |
| **Carbohydrate (gm)** | 55.25 | 53.80 |
| **Protein (gm)** | 6.16 | 8.83 |
| **Total Fat (gm)** | 32.34 | 25.92 |
| **Total Fiber (gm)** | 6.25 | 9.81 |
| **Moisture (%)** | 5.90 | 4.29 |

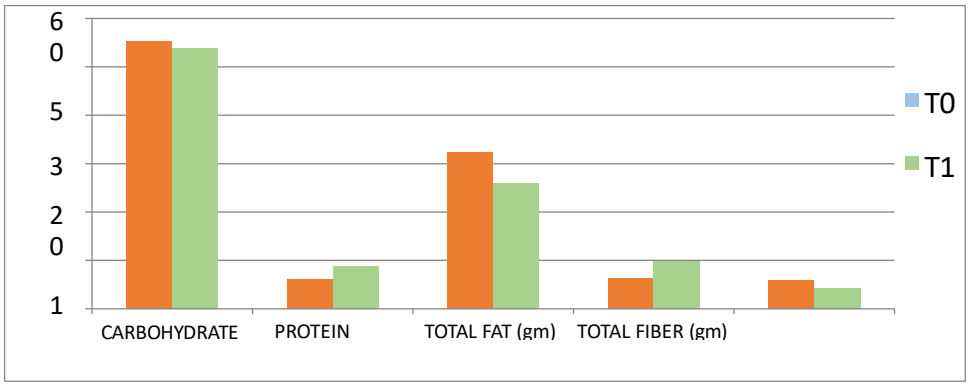


Figure: 1 Comparative representation of proximate composition of control and accepted cookies

## 4. Discussion-

In last few years, consumer interest in healthy eating has recently switched toward the potential health advantages of foods and their constituents [Hoque,et al., 2018]. Since, that a wide range of individuals regularly consume biscuits [Kishor, et al.,2017], using some medicinal plants, such Olive leaves (OL), Bitter gourd fruit (MF), Cheriata leaves (EL), Gurmar leaves (GL), Cinnamon bark (CB), Kokum fruit (GF), Hibiscus flower (HF), Amla fruit (EF), as components in biscuits could have positive health effects. Jemai et.al. 2009 shows antidiabetic and antioxidant effect of olive leaves by the oral administration of extract for 4 weeks [Jemai, et al., 2009]. A study was done by Xin Xu, et al. revealed that Momordica charantia (Bitter gourd) showed that fasting blood glucose level (BGL) was significantly decreased, whereas the glucose tolerance was marked improvement in alloxan-induced diabetic mice, and loss in body weight was also prevented in diabetic mice compared to the diabetic control group. The dosage of 300 mg/kg body weight exhibited the best effects [Xin Xu, et al., 2015]. Treatment of diabetic rats with hot aqueous extract of E. littorale reduced the food, water intake and glucose and AUC glucose levels and decreased the serum glucose, serum cholesterol and triglyceride levels [Vishwakarma, et al., 2010]. *Gymnema slyvestre* leaves posses antidiabetic activity, it improved oral glucose tolerance post sucrose load on both normal as well as STZ-induced diabetic rat [Mishra, et al., 2013]. Treatment of aqueous extract of *Garcinia indica* (400mg/kg) markedly improved oral glucose tolerance in glucose (3g/kg) loaded euglycemic rats. *Hibiscus rosa-sinensis* flowers shows antioxidant, hypoglycemic and hypolipidemic activity against streptozotocin induced diabetic rats, ethanolic extract of flowers, 125, 250 and 500 mg/kg was given to male albino rats shows these activities [Sankaran, et al., 2011]. The study conducted by Akhtar, M. S et al the results showed that both normal and diabetic participants receiving 1, 2 or 3 g of E. officinalis powder per day had significantly lower fasting and 2-hour post-prandial blood glucose levels on the 21st day compared to their baseline readings. Polyherbal formulations are utilized globally, due to its effectiveness and application in medicine and therapy. A study was conducted by Rohith N.T. et.al. on the effect of polyherbal formulation on metabolic derangements. Another study was conducted by Renganathan, S et al administration of Dhanwantaram Kashayam an Ayurvedic polyherbal formulation increased the activity levels of antioxidant enzymes and reduced the levels of total cholesterol, phospholipids and triglycerides. The results of this study point to the possibility of developing Dhanwantaram Kashayam as a dietary

supplement which can alleviate the complications associated with diabetes or prevent them altogether [Renganathan, et al., 2020].

## 5. Conclusion-

Results from the study shows that the cookies with 0.2% of PF had better sensory properties and also have improved nutritional values. Fortification of polyherbal formulation with various food products could help to give functional food products with nutritional and medicinal qualities.

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