Research Article

# Formulation and evaluation of galactagogue herbal motherhood cookies

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## ABSTRACT

**Background:** We analyzed the literature supporting the use of herbs; each herbal drug has been evaluated based on its mechanism of action, effectiveness, and potential side effects for mother and infant, suggested doses for galactagogic effect, and recommendations for breastfeeding. **Aim:** In the present research work, the attempt has been tried for the formulation of lactation cookies by the use of herbal drug (the cookies possess best quality with potent galactagogue effect). **Materials and Methods:** The nutritional studies include moisture content, ash, carbohydrate, protein, fat, and energy contents. Microbial testing of cookies was performed for the determination of (aerobic bacteria) to the study; the shelf life of cookies sensory evaluation was conducted. **Results:** Chemical analysis shows important three parameters which are responsible for the shelf life of biscuits. Percentage moisture contents of the cookies decreased from 1.02% to 1.00%. Ash is 1.11%. The crude fiber content is in range of 3.29–5.73%. The nutritional analysis shows that formulation F4 has the highest percentage of protein (6.18 g/100 g), followed by formulation F3, F2, F5, and F1. The formulation F5 showed the highest percentage of fat (29.32 g/100 g), followed by formulation F2, F3, F1, and F4. The formulation F3 showed the highest percentage of carbohydrate (62.23 g/100 g), followed by formulation F2, F5, F1, and F4. In microbial analysis, the results obtained for total aerobic counts were low in all the cookie formulations ($<10^3$ colony-forming unit/g). **Conclusion:** Cookies with polyherbal substitutions were found to be nutritionally superior; thus, the enriched cookies can conveniently be regarded as a balanced whole meal for lactating mother.

**Keywords:** Galactagogue, lactation cookies, microbial analysis, physicochemical composition

## Introduction

Human milk contains the ideal amount of nutrients for the infant that provides protection from diseases through the mother's natural defenses. Adding lactogenic foods and herbs into one's diet can be very helpful for increasing the nutritional content of mother's milk, poor breast milk production is the most frequent cause of breastfeeding failure. This quite common clinical problem is frequently addressed by physicians by prescribing pharmaceuticals and other products to enhance milk production, namely galactagogues.[1] Galactagogues are medications or other substances believed to assist initiation, maintenance, or augmentation of the rate of maternal milk synthesis. Lactation cookies are a popular and delicious way to add several galactagogues to your diet and keep your energy and morale up as well. Galactagogue cookies can be a great help to moms who want to maintain or increase their milk supply.[2] Motherhood cookies are made up of wheat flours and other baking ingredients. This recipe includes key milk-producing agents, oats are eaten by nursing moms worldwide to boost breast milk supply and are a nutritional powerhouse, providing plenty of whole grains, fiber, iron, and an abundance of healthy vitamins, minerals, and antioxidants as well as *Asparagus racemosus* a common recommendations for better milk supply in Indian cultures. Along with this, soy lecithin has been recommended to combat recurrent plugged ducts. *Lepidium sativum* is a galactagogue and nutrient. *Phoenix sylvestris* is a rich source of iron and fiber.[2]

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## Botanical Description

### Shatavari

Botanical source: It is dried root of *A. racemosus* Willd., belonging to family Asparagaceae, commonly called as shatavari and shatavar.

This plant possesses a variety of biological properties, such as antioxidants, immunostimulants, anti-inflammatory, anti-hepatotoxic, antimicrobial, and reproductive agent. It is also used as diuretic, antispasmodic, galactagogue and ovarian tonic, diuretic, and anti-diarrheal.[3-6]

## Garden cress

Botanical source: It is dried seed of *L. sativum* Linn., belonging to family Brassicaceae, commonly called as garden cress. Seeds of garden cress (*L. sativum*) possess significant nephrocurative and neuroprotective activity. Traditionally it is used as aantimicrobial, antidiabetic and hypocholesterolemic, antihypertensive, hepatoprotective, diuretic, nephrocurative and nephroprtective. It shows anti-inflammatory, antipyretic and analgesic, and galactagogue activity.[6-8]

## Cumin seed

Botanical source: It is dried seed of *Cuminum cyminum*, belonging to family Umbelliferae, commonly called as black cumin. Traditionally it is used as a stimulant, acrid galactagogue and anthelmintic. Having potent carminative, anti-diarrheal, expectorant, and appetizer activity.[6,9]

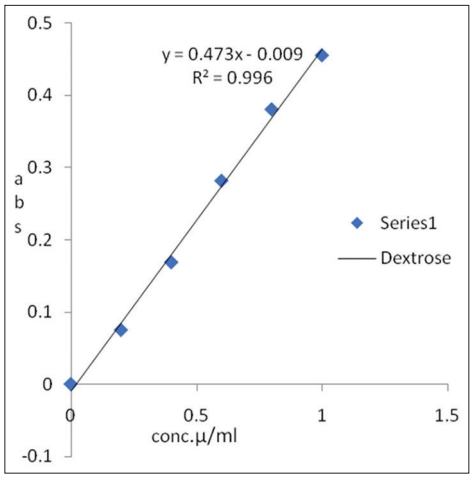


**Figure 1:** Standard curve of carbohydrate (dextrose)

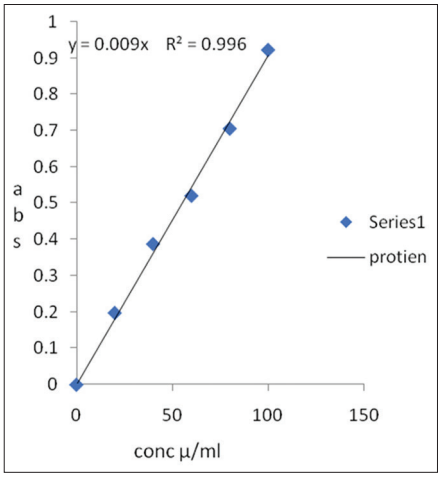


**Figure 2:** Standard curve of protein (glycine)

## Oats

Botanical source: It is dried ripe fruit of *Avena sativa* L., belonging to family of Gramineae, commonly called as oats/oatmeal. As oats contain high fiber content, it is used for constipation, diarrhea gallstones, and irritable bowel syndrome. It reduces high cholesterol oats are also used for acute or chronic anxiety, excitation stress, and galactagogue.[10-12]

## Dates

Botanical source**:** It is dried ripe fruit of *Phoenix sylvestris*, belonging to family Palmae.[6,12,13]

## Soy lecithin

Lecithin is a complex mixture of acetone insoluble phosphatide which consists of phosphatidylcholine, phosphatidylethanolamine, phosphatidylserine, and phosphatidylinositol combined with a various substance such as triglyceride, fatty acid, and carbohydrate as separate from crude vegetable oil source [Figures 1 and 2].[6,14,15]

# Materials and Methods

## Formulation of cookies[16]

The whole wheat flour was mixed with varying inclusions of drug *A. racemosus*, *L. sativum,* soy lecithin, and oats, respectively. The composite flours were blended with other baking ingredients [Table 1] in a mixer, kneaded for 12 min with a kneading machine into the consistent dough. The resulting dough was cut into uniform sizes and passed through a series of molding and shaping. The shaped dough was baked in the oven for 45 min at 170°C; the products were allowed to cool and were subsequently packaged

**Table 1: Formula for motherhood cookie**

| S. No. | Ingredient | Weight/motherhood cookies |
|---|---|---|
| | **Drug** | |
| 1. | *Asparagus racemosus* (extract) | 60 mg |
| 2. | Soy lecithin | 370 mg |
| 3. | *Lepidium sativum* (powder) | 259 mg |
| 4. | *Avena sativa* (oatmeal) | 12.5 g |
| 5. | *Phoenix sylvestris* (dates powder) | 1 g |
| 6. | *Nigella sativa* (cumin powder) | 1.8 g |
| 7. | Wheat flour | 4.1 g |
| | **Baking ingredient in 250 g dough** | |
| 8. | Sugar | 125 g |
| 9. | Milk powder | 25 g |
| 10. | Custard powder | 5 g |
| 11 | Emulsifying agent (ammonia) | Qty sufficient |
| 12. | Vanilla flavor | Few drops |
| 13. | Butter | 125 g |
| 14. | Baking soda | 1/4$^{th}$ tsp |
| 15. | Milk | 50 ml |
| 16. | Salt | A pinch |

with a cellophane wrapper. All the enriched cookies were stored at room temperature, during the period of analytical investigation.

1. Formulation (F1) baking ingredient + wheat flour (4.1 g/cookie) blank
2. Formulation (F2) baking ingredient + seed powder of *L. sativum* (1.6 g/cookies)
3. Formulation (F3) baking ingredient + dried extract of *A. racemosus* (60 mg/cookies)
4. Formulation (F4) baking ingredient + powder of soy lecithin (370 mg)
5. Formulation (F4) baking ingredient + *A. sativa* (oatmeal) 12.5 g/cookie
6. Formulation (F6) baking ingredient + all drug (motherhood cookies)

Note: Nigella sativa powder (1.8g/cookie) and *P. sylvestris* powder (2 g/cookie) mix in all formulation.

## (F6): Formula for motherhood cookies

Each formulation from F1-F6 contain wheat flour as basic component along with baking ingredient, from formulation F2-F5 each formulation contain indivisual galactogogue herb within prescribe pharmacological dose. Formulation F6 is standard formulation having component (wheat flour+ baking ingredient+herbs).

**Table 2: Composition of cookies (F1-F6)**

| S. No. | Ingredient | F1 | F2 | F3 | F4 | F5 | F6 |
|---|---|---|---|---|---|---|---|
| 1. | Wheat flour | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2. | *Lepidium sativum* powder | - | ✓ | - | - | - | ✓ - |
| 3. | *Asparagus racemosus* extract | - | - | ✓ | - | - | ✓ - |
| 4. | Oats | - | - | - | ✓ | - | ✓ - |
| 5. | Soy lecithin | - | - | - | - | ✓ | ✓ - |
| 6. | Cumin powder | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 7. | Dates | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 8. | Baking ingredient | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

## Composition of cookies (F1-F6)

### *Composition of cookies formulation (F1-F6) mention in/cookies*

Each formulation from F1-F6 contain wheat flour as basic component along with baking ingredient, from formulation F2-F5 each formulation contain indivisual galactogogue herb within prescribe pharmacological dose. Formulation F6 is standard formulation having component (wheat flour+ baking ingredient+herbs) [Table 2].

## Evaluation of cookies (in lab testing)

### *Chemical analysis*

a. Moisture content: Water content was determined by Karl Fischer titration method

b. Determination of ash value: Total ash and acid insoluble ash calculated on dry weight basis[17]

c. Nutritional analysis[18-20]

- Carbohydrates: Carbohydrate content was calculated for cookies by difference method on dry using the following formula:
  Total carbohydrate = 100 – (fat + fiber + ash + protein)
- Protein: The crude protein content was estimated according to the Kjeldahl's method as described. Two grams sample was weighed and put into the digestion tube. Twenty milliliters of concentrated sulfuric acid (98%) and two tablets of digestion mixture as catalyst were added into the digestion tube. The digestion was carried out for 3–4 h (until the digested contents attained transparent color). The digested material was allowed to cool at room temperature and diluted to a final volume of 50 ml. The ammonia trapped in $H_2SO_4$ was liberated by adding 40% NaOH solution through distillation and collected in a flask containing 4% boric acid solution, possessing methyl indicator, and titrated against standard 0.1 N $H_2SO_4$ solutions. The factors

**Table 3: Chemical analysis results**

| S. No. | % Parameter | Test method | Result | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | F1 | F2 | F3 | F4 | F5 | F6 |
| 1. | Moisture | Karl fisher | 1.02±0.18 | 1.02±0.14 | 1.03±0.18 | 1.00±0.11 | 1.00±0.17 | 1.00±0.11 |
| 2. | Total ash | I.P.2007 | 1.01±0.41 | 1.05±0.52 | 1.04±0.21 | 1.09±0.022 | 1.08±0.072 | 1.11±0.082 |
| 3. | Acid insoluble ash | I.P. 2007 | 0.09±0.12 | 0.08±0.002 | 0.09±0.13 | 0.09±0.004 | 0.08±0.003 | 0.08±0.001 |
| 4. | Crude fiber (%) | AOAC method 32.10 | 3.29±1.35 | 4.55±1.40 | 5.05±1.43 | 5.73±1.38 | 5.78±1.14 | 5.94±1.23 |

Values are expressed as Mean±SEM, ($n$=3). SEM: Standard error of the mean, AOAC: Association of Official Analytical Chemistry

**Table 4: Nutritional analysis results in lab testing**

| S. No. | % Parameter | Result | | | | | |
|---|---|---|---|---|---|---|---|
| | | F1 | F2 | F3 | F4 | F5 | F5 |
| 1. | Protein/100g | 8.89±0.01 | 7.06±0.011 | 8.08±0.03 | 8.60±0.042 | 7.63±0.09 | 7.88±0.045 |
| 2. | Fat/100 g | 20.06±0.06 | 19.81±0.003 | 17.55±0.001 | 23.26±0.002 | 21.03±0.01 | 20.8±0.002 |
| 3. | Carbohydrate g/100 g | 40.86±0.012 | 42.36±0.015 | 36.88±0.04 | 40.2±0.01 | 39.03±0.04 | 33.6±0.05 |
| 4. | Energy g/100 g | 733.56±0.02 | 689.21±0.04 | 698.21±0.012 | 76.42±0.07 | 714.20±0.03 | 736.21±0.001 |

Values are expressed as Mean±SEM, ($n$=3). SEM: Standard error of the mean

**Table 5: Nutritional analysis results Acrified lab testing**

| S. No. | % Parameter | Test method | Result | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | F1 | F2 | F3 | F4 | F5 | F6 |
| 1. | Protein g/100 g | IS7219:1973 | 5.71 | 5.89 | 5.96 | 6.18 | 5.85 | 6.71 |
| 2. | Fat g/100 g | IS15271:2003 | 24.38 | 27.90 | 27.19 | 24.32 | 29.32 | 27.35 |
| 3. | Carbohydrate g/100 g | USDA agriculture handbook no.74 by calculation | 59.3.14 | 62.23 | 63.45 | 60.56 | 60.30 | 64.14 |
| 4. | Energy kcal/100 g | USDA agriculture handbook | 500.42 | 523.72 | 526.55 | 527.05 | 524.05 | 527.98 |

USDA: United States Department of Agriculture

6.25 and 5.70 were used for the conversion of percent nitrogen into crude protein contents of composite flours and wheat flours, respectively

- Energy: Energy content was calculated for cookies by factorial method using the following formula: Energy (kcal) = 4.0 × protein (g) + 4.0 × carbohydrate (g) + 9.0 × fat (g)
- Crude fiber: The crude fiber was estimated according to the procedure outlined. It was carried out by taking 3 g of each sample and digested first with 1.25% $H_2SO_4$, washed with distilled water and filtered, then again digested with 1.25% NaOH solution, washed with distilled water and filtered. Then, ignited the sample residue by placing the digested samples in a muffle furnace maintained for 3–5 h at temperature of 550–650°C until gray or white ash was obtained.

The percentage of crude fiber was calculated after igniting the samples according to the expression given below.

$$\text{Crude fiber}(\%) = \frac{\text{wt loss on ignition}}{\text{wt of sample}} \times 100$$

## Evaluation of cookies (in Accredited Anacon Laboratory, Nagpur)

a. Physical analysis: The cookies physical characteristics such as height, width, and thickness were measured with digital Vernier calipers with 0.01 mm precision and the spread ratio calculated by the method described by spread factor calculated by formula SF=D/T × CF × 10

Where D is diameter, T is Thickness, CF is correction factor.

b. Nutritional analysis: Carbohydrate and energy contents were determined by the methods described.

## Microbial testing[21-23]

The determination of the microbial quality (aerobic bacteria, coliforms, yeasts, and mold counts) of the products was performed by the method outlined in compendium of methods for the microbiological examination of foods herbal medicinal product containing extract/or herbal drug, with or without excipient where it can be demonstrated that the method of processing (extraction with low strength ethanol or water not boiling or low-temperature concentration) or in case of herbal drug of pretreatment would not reduce the level of organism.

**Table 6: Physical analysis reports from Acrified lab**

| S. No. | Test parameter | Test method | Result | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | F1 | F2 | F3 | F4 | F5 | F6 |
| 1. | Diameter (mm) | AACC (2000) | 58 | 57.6 | 61 | 58 | 57.5 | 65 |
| 2. | Hardness | - | Soft | Soft | Soft | Soft | Soft | Soft |
| 3. | Thickness (mm) | AACC (2000) | 11 | 11.5 | 11 | 10.9 | 11 | 10.6 |
| 4. | Spread factor (mm) | SF=D/T×CF×10 | 52.72 | 52.11 | 55.45 | 53.21 | 58.36 | 59.09 |

Where, SF: Spread factor, D: Diameter, CF: Correction factor, T: Thickness

# Results and Discussion

## Chemical analysis of cookies

Table 3 shows that important three parameters which are responsible for the shelf life of biscuits were investigated. Percentage moisture content in baked cookies is <2%. The moisture contents of the cookies decreased with oat substitution by a range of 1.02–1.00%. High moisture content has been associated with short shelf life of baked products, as they encourage microbial proliferation that leads to spoilage. The ash content also increased from 1.01% to 1.11% in the cookies produced from soybean flour substitution. Ash is an indication of mineral contents of foods. The crude fiber content of the cookies showed a percentage increase in the range of 3.29–5.73% as the whole wheat flour was added with a polyherbal combination of all drugs.

The high crude fiber most likely from the bran of the whole wheat flour and the oatmeal represents a variable fraction of dietary fiber and includes mostly the lignin, cellulose, and hemicelluloses components. Dietary fiber is an edible part of the plant or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fiber includes polysaccharides, oligosaccharides, lignin, and associated plant substances.

## Nutritional analysis of cookies (in lab testing)

Nutrient analysis of cookies for carbohydrates is done according to the American Association of Cereal Chemistry[18] and for protein according to the Indian Pharmacopoeia Commission[24] method No. 46-10. Energy (kcal) = 4 × protein (g) + 4 × carbohydrate (g) + 9 × fat (g) [Table 4].

Nutritive status of biscuit can be established by the nutritive parameters. The major parameters carbohydrates, protein, fat, and energy are determined (Manickum, 2007).

**Table 7: Microbial evaluation of all the formulation**

| S. No. | Test | Limit | Test result | | | | | | Complies/not complies |
|---|---|---|---|---|---|---|---|---|---|
| | | | F1 | F2 | F3 | F4 | F5 | F6 | |
| 1. | Total bacterial count) | $10^3$ CFU/g | 130 | 110 | 60 | 100 | 130 | 110 | Complies |
| 2. | Total fungal count | $10^3$ CFU/g | Nil | Nil | Nil | Nil | Nil | Nil | Complies |
| 3. | Bile tolerant negative bacteria | _ | _ | _ | _ | _ | _ | _ | Complies |
| 4. | *Escherichia coli* | _ | _ | _ | _ | _ | _ | _ | Complies |
| 5. | *Salmonella* | _ | _ | _ | _ | _ | _ | _ | Complies |
| 6. | *Pseudomonas aeruginosa* | _ | _ | _ | _ | _ | _ | _ | Complies |
| 7. | *Candida albicans* | _ | _ | _ | _ | _ | _ | _ | Complies |
| 8. | *Clostridia* | _ | _ | _ | _ | _ | _ | _ | Complies |

All the formulation (-) Indicate absence of microbe, (complies) indicate the microbial limit complies as per Indian Pharmacopoeia and U.S Pharmacopoeia. CFU: Colony-forming unit

**Table 8: Sensory evaluation of cookies by trained penalties**

| S. No. | Test parameter | F1 | F2 | F3 | F4 | F5 | F6 |
|---|---|---|---|---|---|---|---|
| 1. | Taste | 3.0±0.012 | 2.9±.045 | 3.4±0.094 | 3.6±0.056 | 3.3±0.056 | 3.5±0.019 |
| 2. | Crispiness | 3.5±0.031 | 3.5±0.034 | 3.6±0.033 | 3.3±0.045 | 4.4±0.05 | 4±0.03 |
| 3. | Aroma | 3.7±0.012 | 3.2±0.075 | 3.9±0.012 | 3.4±0.034 | 3.8±0.02 | 3.9±0.05 |
| 4. | Appearance | 3.3±0.034 | 3.1±0.045 | 3.2±0.98 | 3.0±0.054 | 3.5±0.03 | 3±0.02 |
| 5. | Color | 4.2±0.04 | 4.3±.067 | 4.2±0.023 | 4.2±.023 | 4.3±0.02 | 4.2±0.08 |
| 6. | Mouthfeel | 2±0.025 | 2±0.019 | 2.3±0.032 | 2.6±0.015 | 2.5±0.06 | 3±0.09 |

Values are expressed as Mean±SEM, ($n$=3). SEM: Standard error of the mean

## Nutritional analysis: (Acrified-lab testing)

The nutritional analysis was done in Accredited Anacon Laboratory, Nagpur. Table 5 shows that formulation F4 has the highest percentage of protein (6.18 g/100 g), followed by formulation F3, F2, F5, and F1. The formulation F5 showed the highest percentage of fat (29.32 g/100 g), followed by formulation F2, F3, F1, and F4. The formulation F3 showed the highest percentage of carbohydrate (62.23 g/100 g), followed by formulation F2, F5, F1, and F4. Similarly, the energy kcal/100 g was found to be highest in formulation F4 as compared to other formulations. However, the F6 formulation which is a combination of all the drug/extracts showed the highest percentage of protein 6.71, fat 27.35, carbohydrate 64.14, and 527.98 kcal/100 g of energy.

The increased fiber and the lower carbohydrate content of cookies have several health benefits, as it will aid digestion in the colon and reduce constipation often associated with products from refined grain flours. The crude fiber contents of the cookies were within the recommended range of not more than 6 g dietary fiber and other nonabsorbable carbohydrates per 100 g dry matter. It is well reported that using whole wheat flour in combination with dates in cookies resulted in improved nutritional and functional properties of the final products.

## Physical analysis: (Acrified lab testing)

All cookies were prepared and analyzed for their physical properties, diameter, hardness, thickness, and spread ratio was measured.

The result of the physical analysis of the cookies obtained from Table 6 shows that the diameter of the cookie formulations F6 and F4 increased as a result of the level of oats substitution. The reverse was observed for the thickness of the cookies. Formulation F2 had the highest value of 11.5 mm. Formulation F6 recorded the highest for spread factor 59.09. The increased spread ratio observed in oat substituted cookie formulations was due to the difference in the particle sizes and characteristics of the constituent of oat the spread factor is an indicator of biscuit.

## Microbiological analysis

The results obtained from the microbial quality investigated are shown in Table 7. The results obtained for total aerobic counts were low in all the cookie formulations ($<10^3$ colony-forming unit [CFU]/g). Formulation F3 (with shatavari substitution) had the lowest microbial counts of 60 CFU/g, saponin content must have been responsible. The oil and fiber contents are critical to the survival of microbes and will ultimately affect the shelf stability and sensory quality of the cookie formulations. There were no observable bacteria and yeast/mould growths from all the cookie formulations. This eliminates the possibility of fecal contamination in the different cookie formulations, which is pointer to good production and handling practice. This could also be due to the dry nature of the cookie.

## Sensory analysis of cookies

Table 8 shows the result of sensory evaluation done by trained penalties, the taste is good in all the formulation and crispiness is good in F5 and F6, it is increased with oats substitution from 3.5 to 4.4. Mouthfeel of cookies is fair in all formulation but F6 is good in F6,

## Conclusion

Enriched cookies with polyherbal substitutions were found to be nutritionally superior (have higher protein, fat, fiber, carbohydrate, and energy content) to whole wheat cookies. Thus, the enriched cookies can conveniently be regarded as a balanced whole meal for lactating mother. The results also show that the cookies are safe for human consumption, considering their low microbial content. However, further research work should be focused on the shelf stability of the enriched cookies, considering that high lipid content would make the cookies to be prone to rancidity. Cookies can increase the nutritional content of mother's milk and delicious to increase lactation.

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