

The Evaluation of the Antioxidant Effect of Indigenous Herbal Formula (*Kayam hodda*) from Different Provinces of Sri Lanka in the Management of Postpartum Complications

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ABSTRACT

Background: Postpartum complications stand for significant challenges in maternal morbidity and mortality along with neonatal development. Antioxidants, a key contributor to preventing postpartum complications such as labor exhaustion, healing lacerations on external genital organs, restoring vigor and vitality, supporting the involution process, and helping in the preparation and secretion of breast milk by preventing oxidative damage, have emerged as potential therapeutic agents to alleviate these complications by neutralizing free radicals, reactive oxygen species (ROS) and reactive nitrogen species (RNS). The nourishment of blood (hematopoiesis) and high energy, the improvement of physique, and the holistic wellness of the mother are essential during the postpartum period. In Sri Lankan traditional medicine, a formula named “*Kayam hodda*” (KH) is the main and most important formula given at the onset of the delivery and during the entire postpartum period. The composition of the KH is different from the provincial vise in Sri Lanka.

Aim: Therefore, the present study was carried out to evaluate the antioxidant capacity of ethanolic extracts of the different KH formulas related to nine provinces in Sri Lanka.

Materials and methods: The antioxidant capacity of the KH formulas was estimated using a stable radical, 1, 1-diphenyl-2-picrylhydrazyl (DPPH) and 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS).

Results: In the DPPH assay, the Western province formula of KH (WPF) extract exhibited the highest antioxidant capacity [$44.38 \pm 0.4\%$ (44.38 mean; 0.70SD; 0.40SE)], while the Northern province formula (NPF) of KH recorded the lowest (7.43 \pm 0.73%). In the ABTS assay, WPF possesses the highest [60.47 ± 1.39 (60.47 mean; 2.41SD; 1.39SE)]. DPPH IC50 of aqueous extract of WPF is 21.95.

Conclusion and clinical significance: This study directs future research on the antioxidant activity of individual ingredients and the benefits of antioxidant activity as a therapeutic strategy to overcome postpartum complications associated with harming radicals to restore the health of the puerperal woman through the preclinical and clinical studies proving the efficacy and safety of KH supplementation during the postpartum period. Moreover, this could be develop as a user-friendly nutraceutical by analyzing and finalizing the required dose, and frequency adjuvants, aiming to restore health with better postpartum care.

Keywords: Antioxidant, *Kayam hodda* formula, Postpartum care, Puerperium, Western province.

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INTRODUCTION

The postpartum period or the puerperium is the time duration after the delivery, initiated just after the expulsion of the placenta, and usually lasts six to eight weeks until the complete physiological and psychological recovery into pre-pregnancy state. This period is important for the puerperal woman and the newborn baby for their health and well-being as it has unique clinical considerations and challenges during this period.¹ The body torment after conveyance is overseen by symptomatic treatment with nonsteroidal anti-inflammatory drugs (NSAIDs), opioids, and neighborhood anesthetics in routine treatment; be that as it may, these are constrained amid breastfeeding, and side impacts, such as gastrointestinal inconvenience, pruritus, clogging, and anaphylactic responses may occur.²⁻⁶ Subsequently, there is an increase in intrigue in elective pharmaceuticals for the treatment of postpartum body torment. Maternity specialists in a few nations utilize homegrown solutions, kneading, Chuna, and needle therapy after the conveyance.⁷

Since ancient times, plants have been used for food as well as medicine the opinion says food is medicine and vice versa. The term nutraceuticals or functional foods has been commenced to use

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since a few decades back that means foods having medicinal value and in the case of plants that have phytochemicals to eradicate or prevent diseases to promote health.⁸

Active phytochemicals identified by the analysis of plant extracts are flavonoids, terpenoids, alkaloids, lignans, sulfides, polyphenolics, carotenoids, coumarins, saponins, plant sterols, curcumins, and phthalides.⁹ For centuries in Sri Lanka, several native plants have been used for food as well as for medicinal purposes. Sri Lankan puerperal women have been given a traditional herbal formula known as "*Kayam hodda*," which is prepared by using spices in the country in the management of postpartum complications and to regain the physical and mental state as in the pre-pregnancy period. It is essential to regain the pre-pregnancy state of puerperal women by following postpartum care which was mentioned in Ayurveda hence, her both physical and mental states have been impaired due to loss of blood, fluid, bodily tissues, and exhaustion during delivery and changes throughout the pregnancy. Postpartum care is proper diet and lifestyle modifications which is helpful in replenishing the both physical and mental status of the puerperal woman. However, in Sri Lanka, there were different formulas found with different ingredients and amounts based on province wise and also on a cultural basis. To date, none of the research studies has evaluated the antioxidant capacity of these different formulas to select the best formula that could be used to develop as an instant-serve food supplement to promote the health of the target population. In this context, the present study aims to analyze the antioxidant activity of different *kayam hodda* formulas used in nine provinces in Sri Lankan Indigenous practice and to select the best formula out of nine formulas to develop as a user-friendly value-added nutraceutical in future studies.

MATERIALS AND METHODS

Data Collection

Different indigenous formulas of *Kayam hodda* used during the postpartum period related to nine provinces in Sri Lanka were obtained from key informants of different traditions with hands-on traditional postpartum practices in their villages and through literature evidence. All the formulas were collected with ingredients used in correct quantities and methods of preparation. Nine formulas related to nine provinces Central, Eastern, North Central, Northern, Northwestern, Sabaragamuwa, Southern, Uva, and Western were collected.

Raw Materials

Raw materials mentioned in the nine formulas have been purchased from local suppliers in Sri Lanka. Nine formulas related to nine provinces in Sri Lanka (Table 1). Nine formulas were prepared with ingredients used in correct quantities and methods of preparation. Extraction of plant chemicals, and determination of antioxidant activity using DPPH and ABTS assays, were performed at the Industrial Technology Institute (ITI), Colombo, Sri Lanka.

Extraction of Plant Chemicals

All the herbal ingredients in the nine formulas first performed their ethanol extraction by using 250 mL of ethanol. Water extraction was done to the best formula selected by using the interpretation of results revealed through DPPH and ABTS assays done for the Ethanol-extracted formulas.

Determination of Radical Scavenging Activity (DPPH Assay)

Nine tests related to the nine areas were arranged with 50 mg of dry extricates of each equation, including 50 mL of methanol arrangement (80%) and optimization was done which is utilized as 200 μ l well volume secured by the plate. Subsequently, 20 μ l from each test was included as it came to 1000 μ l added up to a volume of test combination with 980 μ l buffer arrangement which was crisply arranged methanolic arrangement of DPPH arrangement (1 Mm, 5.85 mL). The blend of DPPH arrangement and test were vortexed for 15 seconds taken after by brooding room temperature for 30 min in a dim range. The absorbance of the tests was watched utilizing a spectrophotometer at a wavelength of 517 nm. Methanol was utilized as the clear and DPPH in methanol without tests was utilized as the positive control sample.

Determination of Radical Scavenging Ability (ABTS Assay)

The ABTS reagent (0.768 g of ABTS in 100 mL of refined water) and 4.9 mM potassium persulphate were blended at the proportion of 1:1. At that point the blend was kept for 16 hours in a dim room. The arranged ABTS arrangement was refined with ethanol 100 times and the absorbance was set to be examined at 0.7 at 734 nm utilizing the UV/VIS spectrophotometer. Tests were weakened with methanol at 250 ppm concentration and were included in 3920 μ l of ABTS stock arrangement. The blend was kept for 10 min at 37°C and the absorbance at 734 nm was perused.

Statistical Analysis

The measurable investigation was done utilizing the IBM SPSS Insights 25 program. Comes about were communicated as cruel +/- standard deviation. *Post hoc* – Turkey's *b* test was utilized to analyze and test the typicality suspicions and consistent fluctuation utilizing remaining versus fits and autonomous presumptions were done through randomizations. ANOVA (One-way investigation of change) was utilized as the measurable device and if *p* esteem < 0.05, contrasts were considered as measurably significant.

RESULTS

As per the findings, we have observed higher absorption (DPPH = 44.38 ± 0.4 and ABTS 60.47 ± 1.39) in the sample from the western province formula (WPF), and secondly eastern province formula (EPF) and thirdly Uva province formula (UPF). In line with this result, we have observed higher mean antioxidant scavenging capacity through the ABTS test (Table 2) WPF: 0.468, and secondly EPF: 0.490, and thirdly UPF: 0.539. DPPH percentage absorption (Table 3) at 100 μ g/mL higher value is recorded in WPF- 44.38 ± 0.4 (44.38mean; 0.70SD; 0.40SE), secondly EPF- 40.38 ± 0.35 (40.38mean; 0.617SD; 0.35SE); thirdly Central province formula 39.87 ± 1.54 (39.87mean; 2.683SD; 1.54SE). Moreover, In the DPPH assay, the Northern province formula (NPF) recorded the lowest [$7.43 \pm 0.73\%$].

One-Way ANOVA-*post hoc* – Turkey's *b* Test was conducted to analyze and compare the mean value of DPPH and ABTS assays related to nine samples in nine provinces. In the DPPH assay, *F* score = 146.32; *df* = (9,20) and the Sig value = 0.000 (<0.05), reject the H_0 and concludes that there is a significant correlation between antioxidant mean values of DPPH assay and provinces. When it comes to ABTS assay, *F* score = 97.29; *df* = (9,20) and the Sig value = 0.000 (<0.05), rejects the H_0 and concludes that there is

Table 1: Nine formulas related to nine provinces in Sri Lanka

Trial readings	Black pepper		Garlic		Cinnamon		Cardamom		Cloves		Turmeric		Bark of Moringa		Garcinia		Tamarind		Ginger		Fenugreek		Nutmeg		Curry leaves		Pandan leaves		Dried chilies		Onion		Red onion		Asafetida		Salt		Fish		
	Coriander	Cumin	Fennel	pepper	10 gm	5 seeds	2 inches	4 fruits	10 gm	10 gm	10 gm	5 gm	2 inches	2 inches	4 seeds	2 seeds	1/2 inch	2 seeds	2 seeds	1/2 inch	10 gm	10 gm	10 gm	10 gm	20 leaves	2 inches	2 pods	8 onions	1 pinch	1 pinch	5 gm	250 gm									
Central province	10 gm	10 gm	10 gm	10 gm	10 gm	5 seeds	2 inches	4 fruits	10 gm	10 gm	10 gm	5 gm	2 inches	2 inches	4 seeds	2 seeds	1/2 inch	2 seeds	2 seeds	1/2 inch	10 gm	10 gm	10 gm	10 gm	20 leaves	2 inches	2 pods	8 onions	1 pinch	1 pinch	5 gm	250 gm									
Eastern province	10 gm	10 gm	10 gm	10 gm	10 gm	4 cloves	2 inches	-	10 gm	10 gm	10 gm	5 gm	2 inches	2 inches	4 seeds	2 seeds	1/2 inch	2 seeds	2 seeds	1/2 inch	10 gm	10 gm	10 gm	10 gm	20 leaves	2 inches	2 pods	8 onions	1 pinch	1 pinch	5 gm	250 gm									
North-central province	10 gm	10 gm	10 gm	10 gm	10 gm	5 cloves	-	-	10 gm	10 gm	10 gm	5 gm	2 inches	2 inches	4 seeds	2 seeds	1/2 inch	2 seeds	2 seeds	1/2 inch	10 gm	10 gm	10 gm	10 gm	20 leaves	2 inches	2 pods	8 onions	1 pinch	1 pinch	5 gm	250 gm									
Northern province	10 gm	10 gm	10 gm	10 gm	10 gm	6 cloves	-	-	10 gm	10 gm	10 gm	5 gm	2 inches	2 inches	4 seeds	2 seeds	1/2 inch	2 seeds	2 seeds	1/2 inch	10 gm	10 gm	10 gm	10 gm	20 leaves	2 inches	2 pods	8 onions	1 pinch	1 pinch	5 gm	250 gm									
North-western province	-	10 gm	10 gm	10 gm	10 gm	5 cloves	2 inches	4 fruits	10 gm	10 gm	10 gm	5 gm	2 inches	2 inches	4 seeds	2 seeds	1/2 inch	2 seeds	2 seeds	1/2 inch	10 gm	10 gm	10 gm	10 gm	20 leaves	2 inches	2 pods	8 onions	1 pinch	1 pinch	5 gm	250 gm									
Sabaragamuwa province	10 gm	10 gm	10 gm	10 gm	10 gm	3 cloves	2 inches	3 fruits	10 gm	10 gm	10 gm	5 gm	2 inches	2 inches	4 seeds	2 seeds	1/2 inch	2 seeds	2 seeds	1/2 inch	10 gm	10 gm	10 gm	10 gm	20 leaves	2 inches	2 pods	8 onions	1 pinch	1 pinch	5 gm	250 gm									
Southern province	30g	30 gm	20 gm	10 gm	10 gm	5 seeds	2 inches	-	10 gm	10 gm	10 gm	5 gm	2 inches	2 inches	4 seeds	2 seeds	1/2 inch	2 seeds	2 seeds	1/2 inch	10 gm	10 gm	10 gm	10 gm	20 leaves	2 inches	2 pods	8 onions	1 pinch	1 pinch	5 gm	250 gm									
Uva province	10 gm	10 gm	10 gm	10 gm	10 gm	4 cloves	2 inches	3 fruits	10 gm	10 gm	10 gm	5 gm	2 inches	2 inches	4 seeds	2 seeds	1/2 inch	2 seeds	2 seeds	1/2 inch	10 gm	10 gm	10 gm	10 gm	20 leaves	2 inches	2 pods	8 onions	1 pinch	1 pinch	5 gm	250 gm									
Western province	-	20 gm	20 gm	10 gm	10 gm	5 seeds	2 inches	-	10 gm	10 gm	10 gm	5 gm	2 inches	2 inches	4 seeds	2 seeds	1/2 inch	2 seeds	2 seeds	1/2 inch	10 gm	10 gm	10 gm	10 gm	20 leaves	2 inches	2 pods	8 onions	1 pinch	1 pinch	5 gm	250 gm									

Coriandrum sativum (Coriander); *Cuminum cyminum* (Cumin); *Foeniculum vulgare* (Fennel); *Piper nigrum* (Black pepper); *Allium sativum* (Garlic); *Cinnamomum zeylanicum* (Cinnamon); *Elettaria cardamomum* (Cardamom); *Syzygium aromaticum* (Cloves); *Curcuma longa* (Turmeric); *Moringa oleifera* (Bark of Moringa); *Garcinia zeylanica* (Garcinia); *Tamarindus indica* (Tamarind); *Zingiber officinale* (Ginger); *Trigonella foenum* (Fenugreek); *Myristica fragrans* (Nutmeg); *Murraya koenigii* (Curry leaves); *Pandanus hasskarlii* (Pandan leaves); *Capsicum annuum* (Dried chilies); *Allium cepa* (Red onion) and *Ferula asafetida* (Asafetida)



Table 2: Antioxidant capacity of indigenous formula of “Kayam hoddā” as determined by DPPH free radical scavenging method
Against DPPH radicals (mol Trolox/g DM) - After ethanol extraction

Trial readings	Control	Northern province	Sabaragamuwa province	North western province	Southern province	Uva province	North central province	Central province	Eastern province	Western province
Trial 1	0.87	0.82	0.75	0.76	0.69	0.55	0.72	0.52	0.53	0.49
Trial 2	0.84	0.83	0.76	0.77	0.71	0.55	0.72	0.53	0.50	0.46
Trial 3	0.89	0.83	0.76	0.77	0.72	0.52	0.71	0.57	0.44	0.45
Mean value	0.87	0.83	0.76	0.76	0.71	0.54	0.72	0.54	0.49	0.47
% in trial 1		6.54	13.88	12.96	20.99	36.70	17.20	40.83	39.68	43.58
% in trial 2			9.71	9.36	16.00	35.19	15.28	36.85	40.64	44.91
% in trial 3		8.32	15.52	14.62	22.50	37.91	18.79	41.96	40.83	44.66
Average		7.43	13.04	12.31	19.83	36.60	17.09	39.88	40.38	44.38
SD		1.26	2.99	2.69	3.40	1.36	1.75	2.68	0.62	0.71
SE		0.73	1.73	1.55	1.96	0.79	1.01	1.55	0.357	0.41
Percentage Absorption at 100 µg/mL		7.43 ± 0.73	13.04 ± 1.73	12.31 ± 1.55	19.83 ± 1.96	36.60 ± 0.77	17.09 ± 1.01	39.88 ± 1.54	40.38 ± 0.35	44.38 ± 0.4

Data expressed as means + standard deviations of three independent extractions (n = 3)

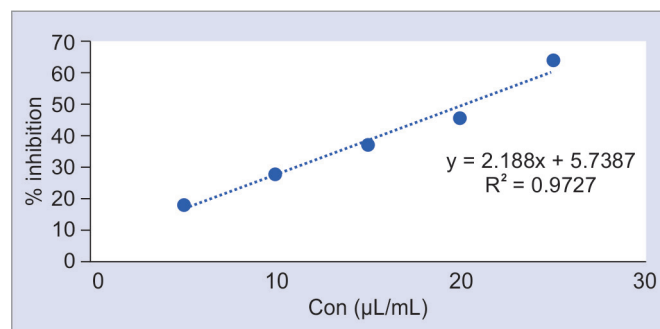
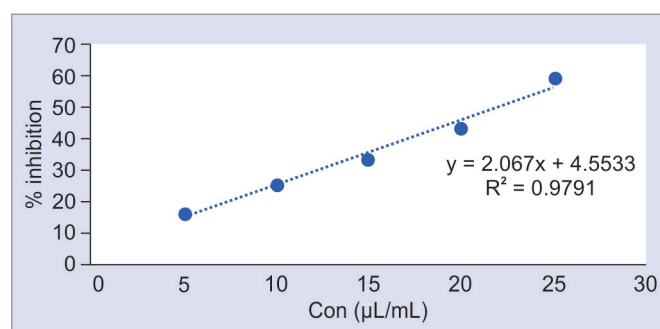
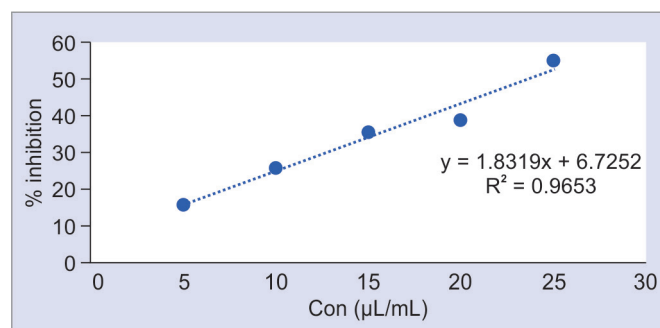
Table 3: Antioxidant capacity of indigenous formula of “Kayam hoddā” as determined by ABTS methods
Against ABTS radicals (mol Trolox/g DM) - After ethanol extraction

Trial readings	Control	Northern province	Sabaragamuwa province	North western province	Southern province	Uva province	North central province	Central province	Eastern province	Western province
Trial 1	1.11	0.97	0.80	0.756	0.52	0.5	0.71	0.52	0.58	0.48
Trial 2	1.14	0.99	0.80	0.74	0.55	0.54	0.72	0.57	0.55	0.47
Trial 3	1.03	0.98	0.79	0.64	0.54	0.61	0.74	0.58	0.55	0.43
% in trial 1		14.06	30.32	34.74	59.04	60.74	39.46	59.24	53.01	62.55
% in trial 2		15.57	29.75	33.60	54.77	56.26	37.71	54.94	49.52	57.83
% in trial 3		11.88	28.47	41.89	50.95	44.70	33.00	47.78	50.59	61.01
Average		13.84	29.51	36.74	54.92	53.90	36.72	53.99	51.04	60.47
SD		1.86	0.95	4.49	4.044	8.28	3.34	5.789	1.79	2.41
SE		1.07	0.55	2.59	2.33	4.78	1.93	3.342	1.03	1.39
Percentage absorption at 50 µL/mL		13.84 ± 1.07	29.51 ± 0.55	36.74 ± 2.59	54.92 ± 2.33	53.90 ± 4.78	36.72 ± 1.93	53.99 ± 3.34	51.04 ± 1.03	60.47 ± 1.39

Data expressed as means + standard deviations of three independent extractions (n = 3)

Table 4: IC50 values of water extract of the western province formula

Concentration ($\mu\text{L/mL}$)	Trial 1	Trial 2	Trial 3	%in trial 1	% in trial 2	% in trial 3
5	0.67	0.67	0.67	18.56	16.50	15.81
10	0.59	0.60	0.59	27.59	25.43	25.72
15	0.52	0.54	0.51	36.63	33.25	35.63
20	0.44	0.46	0.49	45.91	43.42	38.77
25	0.29	0.33	0.36	64.10	59.18	55.08
Control	0.82	0.81	0.80			


Fig. 1: IC50 value of trial 1 = 20.23

Fig. 2: IC50 value of trail 2 = 21.99

Fig. 3: IC50 value of trail 3 = 23.62

a significant correlation between antioxidant mean values of ABTS assay and provinces.

The calculated average IC50 value of the WPF (Table 4) was recorded as 21.95; SD = 1.70; SE = 0.98 (Figs 1 to 3). When analyzing the composition of KH formulas we were able to identify WPF as the only formula that contains *Myristica fragrans* (Nutmeg) and has with highest amount of *Foeniculum vulgare* (Fennel) compared to other provinces' formulas. On the other hand, the least antioxidant activity reported from NPF may be due to the absence of most of

the herbal ingredients like Black pepper, Cinnamon, Cardamom, Cloves, Turmeric, Bark of Moringa, Garcinia, Ginger, Fenugreek and especially in Fennel and Nutmeg.

When comparing with the ingredients of other formulas the most outstanding difference is having *Myristica fragrans L* (Nutmeg) in the WPF. Nutmeg is an evergreen tree belonging to Myristicaceae that is an indigenous plant to Sri Lanka, India, and Indonesia. Essential oil of Nutmeg seed has primary chemical constituents including sabinene, eugenol, myristicin, caryophyllene, beta-myrcene, and alpha-pinene. Experiments have proven the antioxidant, antimicrobial, antidepressant, antiobesity, anti-inflammatory, and analgesic activities of *Myristica fragrans*.^{10–13}

DISCUSSION

Tan et al.¹⁴ reported that Nutmeg has a good antioxidant capacity with phenolic compounds, in higher levels in seed when compared with other plant parts. The antioxidant activity using DPPH: nutmeg essential oils has 3.181 ppm, nutmeg essential oil without myristicin has 33.254 ppm and myristicin has 189 ppm of IC50¹⁵(Table 5). Pashapoor et al.¹⁶ assessed the antioxidant potential of the nutmeg extract using the DPPH assay, which revealed DPPH activity ($R^2 = 0.913$) with the IC50 value of $123.36 \pm 0.76 \mu\text{g/mL}$, while the effect was less significant compared to BHT (Butylated hydroxytoluene, a cresol derivative), an additive used as an antioxidant in foods ($\text{IC}_{50} = 18.51 \pm 0.37 \mu\text{g/mL}$).

Mace extract of nutmeg showed EC50 value for DPPH = 13.41 gm/mL and for ABTS = 12.44 gm/mL, proving its radical scavenging ability.¹⁷ Vangoori¹⁸ has expressed DPPH radical inhibition has been shown in 88% at standard dose of 5 mg/mL. Champasuri and Itharat¹⁹ mentioned that nutmeg showed higher antioxidant action levels when compared with the other plant parts of nutmeg (IC50 values = $21.164 + 1.03$, $28.897 + 0.39$ and $71.830 + 1.33 \mu\text{g/mL}$, respectively).

When comparing the amount of fennel seeds in the formulas, a higher amount is used in WPF whereas NPF does not contain fennel seeds. That might be another reason behind the higher antioxidant value of WPF. Previous research findings revealed the DPPH range of fennel seeds was 70.26–95.69%, ethanol extract has a higher value of DPPH as compared to water extract (96.2 and 84.61).²⁰

Foeniculum vulgare is an aromatic herbal plant belonging to Umbelliferae (Apiaceae), has numerous valuable chemical compounds including volatile compounds, flavonoids, phenolic compounds, fatty acids, and amino acids with primary constituents found in the essential oil of fennel seeds. By analyzing pharmacological studies, it shows several pharmacological actions such as antioxidant, antimicrobial, antiviral, anti-inflammatory, estrogenic, antipyretic, antimutagenic, antispasmodic, antithrombotic, memory enhancing, and immunomodulatory actions. Furthermore, it has galactagogue property, which is essential during the postpartum period for lactating mothers.

Table 5: Active chemical compounds and pharmacological actions of all the ingredients of nine provinces formulas in Sri Lanka

Botanical name	Used part of plant	Active chemical compound	Pharmacological action on postnatal complications
<i>Coriandrum sativum</i> (coriander)	Seeds	Linalool	Antioxidant, antibacterial immunomodulatory, sedative
<i>Cummin cyminum</i> (cumin)	Seeds	Cuminaldehyde	Anti-inflammatory, analgesic, antiseptic sedative, immunomodulatory
<i>Foeniculum vulgare</i> (fennel)	Leaves	Trans-anethole	Antimicrobial, analgesic, antipyretic, lactation, stimulant
<i>Piper nigrum</i> (black pepper)	Seeds	Piperine	Anti-inflammatory, analgesic, antioxidant, immunomodulatory, antimicrobial, antipyretic, antidepressive
<i>Allium sativum</i> (garlic)	Bulb	Allicin	Antimicrobial, antioxidant
<i>Cinnamomum zeylanicum</i> (cinnamon)	Bark	Cinnamaldehyde	Anti-Inflammatory, Antimicrobial, Antioxidant, Lipid Lowering
<i>Elettaria cardamomum</i> (cardamom)	Seeds	Cineole	Antioxidant, anti-inflammatory
<i>Syzygium aromaticum</i> (cloves)	Seeds	Euginol	Anti-inflammatory, analgesic
<i>Curcuma longa</i> (Turmeric)	Rhizome	Curcumin	Antimicrobial, antioxidant, anti-inflammatory, immunomodulatory
<i>Moringa oleifera</i> (bark of moringa)	Bark	Myricetin	Lactation stimulant, antioxidant, anti-inflammatory, immunomodulatory
<i>Garcinia zeylenica</i> (garcinia)	Fruits	Xanthenes benzophenones	Anti-inflammatory, antibacterial, antiseptic, antidepressant
<i>Tamarindus indica</i> (tamarind)	Fruits	Tartaric acid	Anti-inflammatory, analgesic, antipyretic
<i>Zingiber officinale</i> (ginger)	Rhizome	Gingerols, Shogaols Paradols	Anti-inflammatory, analgesic
<i>Trigonella foenum</i> (fenugreek)	Seeds	Galactomannan	Anti-inflammatory, antioxidant, immunomodulatory
<i>Myristica fragrans</i> (nutmeg)	Seed cover	Myristin	Anti-inflammatory, antiseptic, antioxidant, antimicrobial
<i>Murraya koenigii</i> (curry leaves)	Leaves	Carbazole alkaloids	Antimicrobial, antioxidant
<i>Pandanus hasskarlii</i> (pandan leaves)	Leaves	Pandamarine	Anti-inflammatory, antimicrobial
<i>Capsicum annuum</i> (dried chillies)	Fruits	Capsaicinoids	Antioxidant, anti-inflammatory
<i>Allium cepa</i> (red onion)	Bulb	Quercetin kaempferol	Antioxidant, anti-inflammatory, antidepressant
<i>Allium cepa</i> (onion)	Bulb	Allicin quercetin	Analgesic, wound healing
<i>Ferula asafetida</i> (asafetida)	–	α-pinene	Anti-inflammatory, antispasmodic, antimicrobial
Salt	–	Sodium chloride	Anti-inflammatory, antiseptic
Fish	–	Omega-3 fatty acids	Lipid lowering, antiarrhythmic

Although there is no evidence recorded regarding teratogenicity, it is better to avoid the usage of fennel during the antenatal period due to its estrogenic activity may have a negatively effect on endometrial receptivity which helps to maintain the pregnancy.^{21–24}

Therefore, the least antioxidant range in the NPF may be due to the absence of fennel seeds in combination with other materials. Also, it lacks Cinnamon, Moringa bark, Garcinia or Tamarind, and even curry leaves compared to the WPF. Therefore, NPF may not be able to provide a better synergistic effect on antioxidant value. Many lifestyle and dietary regimens should be followed during the postpartum period and proper nutrition is highly emphasis among them. Diet therapy includes the dosage forms prepared from medicinal plants in the form of decoctions, hot/cold infusions, or extracts.²⁵ According to traditional medicine, it is believed that medicinal herbs will be effective in the management of postpartum disorders and complications including body pain, insomnia, indigestion, postpartum blue or depression, oxidative stress, inflammatory disorders, wounds with lacerations or episiotomy as well as restoring of the natural physiology and anatomy of the body called uterine involution balance of hormones and for lactation. The

dietary regimen is also essential to the production and secretion of breastmilk and for the growth and development of the infant since the nutrition is passed from mother to child as bioactive molecules through lactation.²⁶ “*Kayam hodda*” formula has the property to recover postpartum women to their healthy physical and mental state, preventing postpartum complications and effects as a galactagogue to enhance the growth of the newborn baby as evidenced by the pharmacological properties of the ingredients as well as analytical results of the Antioxidant tests. Based on a pharmacological review, the ingredients of the formula are rich in antioxidant, antimicrobial, anti-inflammatory, and wound healing, analgesic, immunomodulatory, antidepressive, galactagogue, antipyretic, and sedative actions.

“*Kayam hodda*” formula also has the best galactagogue properties as important as breast-feeding follows the optimal nutrition for the baby as well as for the better relationship between mother and baby hence, the majority of ingredients have lactation stimulation properties.²⁷ It may be helpful to improve the antioxidant property of breast milk with a supplement having a lactation stimulant and higher antioxidant activity.

This research study achieved the Sustainable Development Goals (SDGs 3) as good health and well-being under the theme of ensuring healthy lives and promoting well-being for all at all ages. There, the important indicators are life expectancy and child as well as maternal mortality, created by the United Nations Foundation in 2015 under the Agenda for sustainable development 2030 emphasized the interconnection of global health, economic, social, and environmental challenges.²⁸

In each stage, it is important to ensure the health and well-being of both the mother and the baby. Although, important progress has been made in the last two decades, globally about 2,87,000 women died during and following pregnancy and childbirth in 2020. Most maternal mortality issues can be prevented with proper timely management by a skilled health professional working in a supportive environment with proper diet and lifestyle modifications which is helpful in replenishing both the physical and mental status of the puerperal woman.²⁹

The general objectives of postpartum care are to relieve the exhaustion of labor, to heal lacerations on external genital organs, to restore vigor and vitality, to support the involution process, and to help in the preparation and secretion of breast milk. Nutrition is an essential aspect of postpartum care as it allows the puerperal woman to regain her strength after delivery.³⁰ Based on the literature evidence of the previous studies (Table 5), all the ingredients related to WPF have been proven to have antioxidant activity. It is essential to study their antioxidant value individually and then build up a conclusion regarding the synergism of the highest antioxidant capacity of the formula. It will be studied further in the future as the next step in the current research work to introduce the best consumer in the ailments of the target population promising therapeutic potential for preventing and managing postpartum complications. Moreover, it is essential to evaluate biochemical and clinical outcomes and safety to develop economically reliable and user-friendly value-added nutritional supplementation for puerperal women.

CONCLUSION

In conclusion, WPF is highly useful as a dietary supplement and has a medicinal value against postpartum complications. This study directs future studies on the antioxidant activity of each individual ingredient and the eradication of radicals or the importance of antioxidants as a tool having a valuable therapeutic effect to overcome postpartum complications in relation to oxidative damage of the cells due to free radicals and to restore the health of the puerperal woman through the preclinical and clinical research studies proving the efficacy and safety of KH supplementation throughout the postpartum period.

Limitations

The limitation of this study is KH formula was not studied for other pharmacological activities including analgesic, anti-inflammatory, antimicrobial activity, galactagogic, etc.

Clinical Significance and Recommendations

Further, the present study could be developed as a user-friendly nutraceutical by analyzing and finalizing the required dose, frequency, and adjuvants, aiming to restore the health of puerperal women with better postpartum care. Moreover, it is essential to evaluate biochemical and clinical outcomes and safety to develop economically reliable and user-friendly value-added nutritional supplementation for puerperal women.

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