

1-1-2013

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### Recommended Citation

Keeta, Itsara; Sawang, Nahathai; and Potduang, Buppachart (2013) "DEVELOPMENT OF HAIR CONDITIONING AND STYLING GEL COMPRISING A MIXED EXTRACT FROM FRUITS OF P. EMBLICA AND Z. LIMONELLA," *The Thai Journal of Pharmaceutical Sciences*: Vol. 38: Iss. 0, Article 56.  
Available at: <https://digital.car.chula.ac.th/tjps/vol38/iss0/56>

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DEVELOPMENT OF HAIR CONDITIONING AND STYLING GEL COMPRISING A MIXED EXTRACT FROM FRUITS OF *P. EMBLICA* AND *Z. LIMONELLA*Itsara Keeta<sup>1</sup>, Nahathai Sawang<sup>2</sup> and Buppachart Potduang<sup>1,\*</sup>

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**KEYWORDS:** Hair styling gel, Gelling agent, *P. emblica*, *Z. limonella*, Antioxidant**INTRODUCTION**

Hair gel is a hairstyling product that is used to stiffen hair into a particular hairstyle. Many gels contain adhesive agents which will make the hairs stick together as they dry in the configuration determined by the styling process to give the style added strength and allow it to hold longer.<sup>1</sup> Cationic polymers are one of the main functional components of hair gel. The positive charges in polymer cause it to stretch, making the gel more viscous. Hair gels resist natural protein conformations and allow hair to be styled and textured. This is because the stretched-out polymer takes up more space than a coiled polymer and thus resists the flow of solvent molecules around it. The positive charges also bind the gel to the negatively charged amino acids on the surface of the keratin molecules in the hair. More complicated polymer formulas exist.<sup>2,3</sup>

The edible fruits of Ma-khampom (*Phyllanthus emblica* Linn., EUPHORBIACEAE) are used as an important constituent of many Ayurvedic preparations such as chyavanprash and triphala and is regarded as one of the best rejuvenating herbs. The fruits are globular, fleshy, smooth, and striated, of yellowish-green color. They contain an obovate-obtusely triangular six-celled nut. Traditionally, the fruit is useful as an astringent, cardiac tonic, diuretic, laxative, liver tonic, refrigerant, stomachic, restorative, alterative, antipyretic, anti-inflammatory, hair tonic, and digestive medicine. It is used for a variety of ailments such as anemia, hyperacidity, diarrhea, eye inflammation, anomalies of urine, leucorrhea, jaundice, nerve debility, liver complaints, and cough. It is reported to have hepatoprotective, antioxidant, antimutagenic, cytoprotective, antitumor, antifungal, antimicrobial, hypolipidemic, and antiatherosclerotic effects. The fruit contains two hydrolysable tannins, emblicanins A and B, which have antioxidant properties; one on hydrolysis gives gallic acid, ellagic acid and glucose, whereas the other gives ellagic acid and glucose.<sup>4,5,6,7</sup>

Dry ripe fruits of Ma-khwaen (*Zanthoxylum limonella* Alston, RUTACEAE) are commercialized in local markets in the northern part of Thailand. They have been traditionally used in food as a popular spice. The essential oil from these fruits contains vitamin E and sabinene, which is potently bactericidal against the multi-drug resistant bacteria.<sup>8,9</sup>

The patented mixed extract from fruits of *P. emblica* and *Z. limonella* is effective as an *in vitro* antioxidant (EC<sub>50</sub> 7.9 mg/ml)<sup>9</sup>. This research aimed to develop a hair conditioning and styling gel for damaged hair comprising the mixed extract. The product would also benefit from the antioxidant effect of the extract other than nourishing the hair.

**MATERIALS AND METHODS**

**Plant material** The dry, powdered fruits of *P. emblica* and *Z. limonella* were provided by the Sakaerat Biosphere Research Center, Agricultural Technology Department of TISTR.

**Preparation of the mixed extract** *P. emblica* extract and *Z. limonella* extract was separately prepared by macerating the powdered fruits with ethanol-water for 3 nights, filtering through Whatman paper No.41 and rinsing with the same solvent. The solvent was removed under reduced pressure using a rotary evaporator (Heidolph, Hei-VAP Precision) at 45 °C. The crude extracts were mixed at an appropriate patented ratio.

**Formulation of hair conditioning and styling gel** Hair conditioning and styling gel consisting of the *P. emblica* and *Z. limonella* mixed extract was formulated into 5 formulas. In formulas 1 and 2, the basic formula was varied in the type of carbopol. In the formulas 3, 4 and 5, the basic formula was varied in the amount of carbopol and other ingredients, as shown in Table 1.

**Table 1** Basic formulas of the hair conditioning and styling gel

Ingredients	Function	F 1	F 2	F 3	F 4	F 5
		%w/w	%w/w	%w/w	%w/w	%w/w
Carbopol ultrez 10	Gelling agent	-	0.50	-	-	-
Carbopol 940	Gelling agent	0.50	-	A3	A4	A5
Propylene glycol	Humectant, diluent	10.00	10.00	10.00	10.00	10.00
Glycerin	Humectant	8.00	8.00	X	X	X
Panthenol (pro vitamin B5)	Moisturizer	1.00	1.00	1.00	1.00	1.00
Polyquaternium-10	Conditioning agent	-	-	-	B4	B5
Disodium EDTA	Chelating agent	0.10	0.10	0.10	0.10	0.10
PEG-12 dimethicone	Plasticizer	0.50	0.50	C3	C4	C5
Cyclomethicone	Conditioning agent	-	-	0.50	0.50	0.50
Jjoba oil	Conditioning agent	-	-	0.50	0.50	0.50
Tocopheryl Acetate	Antioxidant	-	-	0.20	0.20	0.20
Preservative	Preservative	0.50	0.50	0.50	0.50	0.50
Active mix extract	Active ingredient	D	D	D	D	D
Triethanolamine	Neutralizer	q.s.	q.s.	q.s.	q.s.	q.s.
Fragrance	Fragrance	q.s.	q.s.	q.s.	q.s.	q.s.
Water	Diluent	q.s. to 100	q.s. to 100	q.s. to 100	q.s. to 100	q.s. to 100

**Stability test** The stability of the hair conditioning and styling gel in the accelerated conditions was assessed using heating and cooling method which defined as alternation of storage conditions from 4°C for 24 hrs and 45°C for 24 hrs (1 cycle) for 6 cycles. The physical stability of samples was evaluated based on turbidity, precipitation and appearances.

## RESULTS

**Development of hair conditioning and styling gel** The hair conditioning and styling gel containing the patented mixed extract from fruits of *P. emblica* and *Z. limonella* was formulated into 5 formulas. The appearances of each formula are shown in Table 2. All formulas were stable and did not separate under centrifugation and stability testing.

**Table 2** The appearances of hair conditioning and styling gel formulas

Formula	Appearances
1	Clear, viscous and not greasy
2	Clear, not viscous and not greasy
3	More viscous than formula 1, opaque, light yellow, did not hold hair, not sticky and not greasy
4	More viscous than formula 1 and 3, opaque, light yellow, weakly hold hair, not sticky and not greasy
5	More viscous than formula 1, 3 and 4, opaque, light yellow, weakly hold hair, not sticky and not greasy

## CONCLUSION

The patented mixed extract from fruits of *P. emblica* and *Z. limonella* could be used as an active extract for hair conditioning products which benefits from its antioxidant efficacy. The products will nourish the hair as well as protect it from UV damage. The best formula of hair conditioning and styling gel is formula 5, which was stable under 6 test cycles of heating and cooling.

## ACKNOWLEDGMENTS

This study was supported by the Pharmaceutical and Natural Products Department, Thailand Institute of Scientific and Technological Research (TISTR). We thank all TISTR colleagues who in one way or another help this project to succeed.

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