



Original Article

Development and clinical efficacy evaluation of anti-greasy green tea tonner on facial skin



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ABSTRACT

Green tea (*Camellia sinensis* (L.) Kuntze, Theaceae) polyphenols have activities against skin disorders; however, anti-sebum efficacy of green tea cosmetic has sparsely been reported. The facial tonner containing green tea was therefore developed and clinical evaluated. The base formulas which stabled following accelerated tests were sensorial assessed in ten volunteers. The base with hydroxyethyl cellulose, glycerin and panthenol (totally 3.6%) with the significant ($p < 0.05$) preference ($82.3 \pm 0.55\%$) over the others was further developed to green tea preparations. All of the products were stable and caused none of skin irritation as closed patch tested in twenty volunteers. Thereafter, they were clinical evaluated in the same group of the volunteers and monitored with Sebumeter[®] by means of a split-face, randomized single-blind, placebo-controlled study. Anti-greasy efficacy of 2, 4.5 and 7% green tea tonners were 3.47 ± 0.10 , 8.18 ± 0.44 and $17.87 \pm 0.46\%$ following 14 days of facial treatment. The efficiency was pronounced at the end of the study; day 28 (8.48 ± 0.13 , 20.26 ± 1.03 and $31.57 \pm 1.22\%$). Anti-sebum efficacy of the 4.5 and 7% green tea tonners were significantly better than the base formula (day 14; $p < 0.05$, day 28; $p < 0.01$). The efficacy of 28 days treatment was significantly better than 14 days ($p < 0.05$). The safe and efficient green tea tonner for oily face treatment was therefore approved in this context.

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Introduction

Green tea or *Camellia sinensis* (L.) Kuntze, Theaceae, is widely used for anti-aging (Elmets et al., 2001; Kartiyar and Elmets, 2001) and hydrating (Aburjai and Natsheh, 2003; Hsu, 2005) cosmetics either as the single active or in a combination with others (Chuarienthong et al., 2010). In addition, green tea possesses inhibitory effects against 5α -reductase (Lourith and Kanlayavattanakul, 2013) and androgen esthetic disorders. It is therefore applicable for body and oral malodor treatments (Lourith and Kanlayavattanakul, 2010; Kanlayavattanakul and Lourith, 2011) accordingly.

Oily skin usually refers to a facial condition with a shiny appearance and greasiness and heaviness due to excessive sebum production and secretion. This esthetic problem leads skin disorders such as acne, and significantly adverse quality of life (Wu et al., 2013) consequently. Thus, an application of cosmetics to reduce greasiness of skin is of challenge. Green tea facial tonner was therefore developed. The stable preparations were preference

assessed and skin irritation by means of a single closed patch test was conducted as consequently. A split-face, randomized single-blind, placebo-control clinical evaluation of the green tea tonners was thereafter examined with Sebumeter[®].

Materials and methods

Formulation and stability evaluation

Base tonners containing gelling agent selected from xanthan gum, carbopol and hydroxyethyl cellulose at different proportions, and tween 80, glycerine, panthenol, PEG/PPG-18/18 dimethicone, triethanolamine, preservative (Namsiang, Thailand) and water were formulated. Those with hydroxyethyl cellulose afforded the clear color less tonner with a preferred texture were therefore developed as shown in Table 1. pH of the tonners were determined (QIS, B200, the Netherlands). The obtaining three base formulas that were stable following accelerated stability test by means of a centrifugation assay ($805 \times g$ for 30 min) using Micromax RF (Thermo, USA), and six cycles of acceleration test (heating and cooling at 4°C and 45°C for 48 h, each cycle) (Chaisripipat et al., 2015), were included for preference test. The preferred tonner base

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Table 1
Development of the stable green tea tonners.

Ingredient	Base (% w/w)			Green tea tonner (% w/w)		
	A	B	C	B1	B2	B3
Hydroxyethyl cellulose	0.1	0.1	0.1	0.1	0.1	0.1
Glycerin	1	3	4	3	3	3
Panthenol	↑	↑	↑	↑	↑	↑
PEG/PPG-18/18 dimethicone	3.5	3	4.5	3	3	3
Tween 80	↓	↓	↓	↓	↓	↓
Preservative	0.5	0.5	0.5	0.5	0.5	0.5
Triethanolamine	0.2	0.2	0.4	0.2	0.2	0.2
Water	94.7	93.2	90.5	91.2	88.7	86.2
Green tea extract	–	–	–	2	4.5	7
pH						
Int.	5.51 ± 0.03	5.55 ± 0.05	5.56 ± 0.02	5.56 ± 0.01	5.61 ± 0.02	5.51 ± 0.01
HC	5.60 ± 0.02	5.62 ± 0.03	5.62 ± 0.03	5.61 ± 0.01	5.67 ± 0.03	5.62 ± 0.09
Preference (%)						
Spreadability	88 ± 1.03	94 ± 0.96	80 ± 1.33			
Skin absorption	78 ± 1.47	88 ± 1.03	70 ± 1.69			
Greasiness	84 ± 0.84	92 ± 1.03	72 ± 1.03	NA	NA	NA
Color	82 ± 1.47	94 ± 0.96	68 ± 1.93			
Odor	60 ± 0.94	66 ± 0.96	58 ± 1.47			
Overall preference (%)	77.6 ± 0.63	82.3 ± 0.84	73.6 ± 10.3			

HC, heating and cooling; NA, not available.

was incorporated with green tea extract with 100 mg% of polyphenols (Product code: HE-EL11-CAS) supplied from Specialty Natural Products (Thailand). The obtaining green tea tonners were stability evaluated as above.

Preference test

Preference test for the base tonner was carried out in six female and four male Thai volunteers aged between 21 and 35 years old by means of the interview questionnaires with the hedonic system scoring from 1 to 5 (dislike – most prefer). The preferred base which passed the stability test was chosen for further development (Chaisripipat et al., 2015).

Clinical evaluation

Inclusion criteria

Thai healthy volunteers aged between 20 and 35 years old were enrolled in the study. The inclusion criteria for the volunteer was based on the facial sebum content between 180–250 and 160–250 µg/cm² for male and female subjects, respectively, as assessed by Sebumeter[®] (SM810, CK, Germany). All recruited subjects were informed about the study both in writing and verbally and signed a written consent form, which was approved by the ethical committee of Mae Fah Luang University prior to enrollment (REH-59083). All of the study in human volunteers was delineated by the Declaration of Helsinki.

Irritation test

Base tonner was comparatively examined with the green tea tonners. Water was used as a negative control, whereas 3% sodium lauryl sulfate (Namsiang) was a positive control. Observation was undertaken immediately, 24, 48 and 72 h following Finn chamber[®] (8 mm, SmartPractice, USA) removal. Mean Irritation Index (MII) was calculated (Schnuch et al., 2008).

Efficacy evaluation

Twenty healthy Thai volunteers (sixteen female and four male) aged between 20 and 35 years old were included. All subjects were allergy-free for one week, had not used steroids and topical products for oily or greasy face treatment for four weeks prior to study

enrollment. Subjects who were pregnant or lactating or dieting were excluded from the study as well as smoking and liquor drinking. The subjects were asked not to apply any products onto the face the night before starting the study. They were all facial greasiness determined with Sebumeter[®] at the baseline. The subjects were acclimatized in the waiting room (20 ± 1 °C and 40–60% relative humidity) for 30 min before the measurements were carried out under the same condition. A randomized single-blind placebo-controlled study was designed and the volunteers were requested to apply the tonner once in the morning by a split-face procedure for intra-individual comparative trails. The volunteers were directed to use ten drops of the tonner absorbed on the cotton pad (Ambulance, Thailand) on one face side and the different tonner on another side at the same quantity. The subject who used the assigned product less than 90% of the guideline was listed in the discontinuation criteria. The efficacy evaluation was monitored on days 14 and 28 by Sebumeter[®] under the same condition with the baseline. Anti-sebum efficacy was calculated as followings:

$$\text{Anti-sebum efficacy (\%)} = 100 - \left(\frac{St}{S0} \times 100 \right)$$

where

St = sebum content (µg/cm²) at time interval
S0 = sebum content (µg/cm²) at base line

Statistical analysis

The parameters were compared and analyzed using Post Hoc test for stability and preference tests. Independent sample t test was for efficacy evaluations. The significance was set at a reliability of 95%, and expressed as mean ± SEM.

Results and discussion

Formulation, stability evaluation and preference test

The base formulation was firstly developed by a variation of gelling agents, at which hydroxyethyl cellulose was chosen for further development (Table 1) due to its appearance and texture. All of the tonners were clear, colorless liquid that stabled following

centrifugation assay and heat cool cycles, pH was slightly shifted. Their preferences were examined in terms of spreadability, skin absorption, greasiness, color and odor. Tonner B gained the highest preference of all terms with a significant overall satisfied (Table 1). Therefore, it was developed into green tea tonner with various proportions of green tea extract (Table 1) as delineated by the reported facial sebum reduction (Mahmood et al., 2010, 2013; Sharquie et al., 2014). According to the Certification of Analysis (COA) supplied with green tea extract, polyphenols content of the 2, 4.5 and 7% green tea tonners were therefore 2, 4.5 and 7 mg, respectively. The greater content of active did not effect on the products' pH. All of the green tea tonners were stable following accelerated stability tests. Therefore, clinical evaluation in the human volunteers was examined consequently.

Clinical evaluation

A single closed patch test was conducted (Mahmood et al., 2013) and all of the green tea (B1–B3) and base (B) tonners were found negative in similar to water (MII=0), in contrary to the positive control (SLS; MII=0.15). Sodium lauryl sulfate at 3% was examined in parallel as the positive control to ensure that the included volunteers are not tolerating with any dermal irritation. On the meantime that water was analyzed as the reference of negative results in an order to control the study from any interference (Schnuch et al., 2008). Thus, the included volunteers are confirmed sensible for the preliminary irritation test, and the green tea tonners are ensured in terms of their safety accordingly. Anti-sebum efficacy of the preparations was evaluated consequently. Greasiness of skin can be assessed by several methods on the basis of absorbent paper pads, photometric assessment, bentonite clay and lipid-sensitive tapes, of which photometric method by means of Sebumeter® is the most commonly method (Sakuma and Maibach, 2012). This quantitative measurement technique is a precise method report the sebum content in the unit of $\mu\text{g}/\text{cm}^2$ and applicable for claim support (Crowther, 2016).

Sebum content of different three spots on the T-zone line, i.e. forehead, cheek and chin, were determined. Green tea tonners reduced facial sebum level, and significantly reduced better than the base line after 14 and 28 days of application ($p < 0.05$ and 0.01), but not the base formula as shown in Fig. 1. The overall efficacies of green tea tonners were clearly better than the placebo particularly the 7% green tea extract (Fig. 2) that significantly better than 4.5 and 2% green tea tonners ($p < 0.05$) at all of the intervals.

Oily facial skin was successively treated with the developed green tea tonners. The green tea tonners and base were able to reduce the facial sebum content, of particular the 7% green tea tonner. The anti-sebum efficacies of 4.5 and 7% green tea tonners with 20.26 ± 1.03 and $31.57 \pm 1.22\%$ at the end of the study were better than the consumers' satisfied level (10%) (Piérard-Franchimont et al., 2010) as per that of 7% green tea tonner following 14 days of treatment ($17.87 \pm 0.46\%$). In addition, these developed tonners were better in efficacy than gel (500 mg) containing 2% compound of *Sesamum indicum* or sesame, kernel oil (*Argania spinosa*) and saw palmetto (*Serenoa serrulata*) extracts, which was 19.7% reduced facial sebum content following four weeks as assessed by the same method (Dobrev, 2007). Furthermore, the efficacy of these green tea tonners were better than the reported 5% green tea emulsion 29.14% sebum reducing after 30 days of treatment (Mahmood et al., 2013). Sebum secretion was greater reduced with the presenting tonners than the 2% L-carnitine preparation (0.52 ± 0.87 and 0.71 ± 0.96 following 2 and 3 weeks applications) (Peirano et al., 2011). The safe and efficient green tea tonner for oily face treatment was therefore approved in this context. The tonners are appraisal for a daily application in an order to enhance the efficacy and none of the volunteers reported adverse effect. In addition,

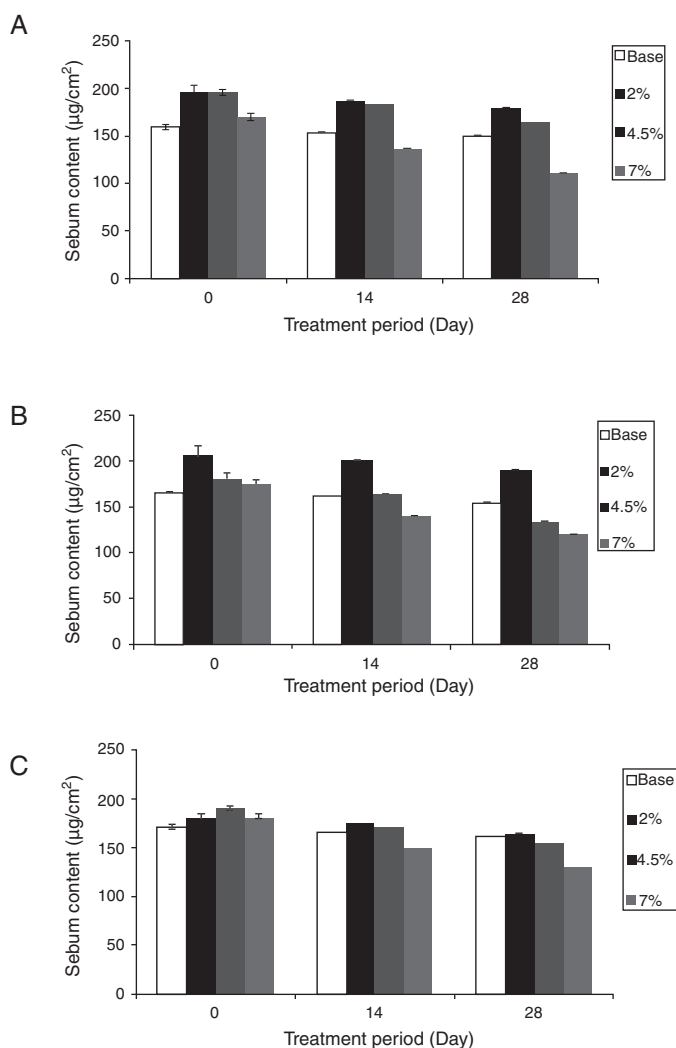


Fig. 1. Sebum content of forehead (A), cheek (B) and chin (C) after treatment with the base and green tea tonners at different time intervals.

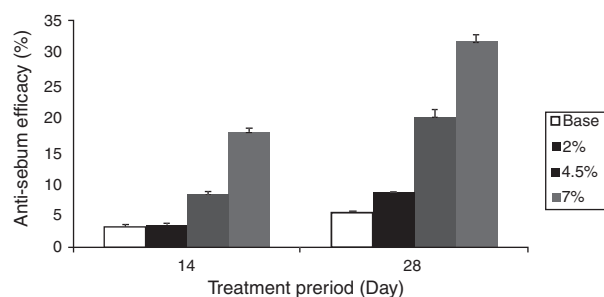


Fig. 2. Anti-sebum efficacy of the green tea tonners at a different time of treatment compared with the base.

application of green tea extract, herb with several health benefit biological properties, for facial greasiness treatment is encourage.

Authors' contributions

PM (MSc student) contributed in all the experimental work, analyzed the data. MK contributed to project plaining and drafting of the manuscript. NL designed the study and contributed to critical reviewing of the manuscript. All the authors have read the final manuscript and approved the submission.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

Conflicts of interest

The authors declare no conflicts of interest.

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