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Lipidomics Analysis of Sensitive Skin Aging in Chinese Women Aged 22-28 and 29-35 Years Based on the Division of Women's Life Rhythm in the Yellow Emperor Internal Classic

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Abstract

Purpose: To explore sensitive skin facial physiological parameters and lipid differences caused by skin aging. **Methods:** Female volunteers with sensitive skin were enrolled into the S1 group (22-28 years old) and the S2 group (29-35 years old). Skin surface lipid samples and physiological parameters were collected by non-invasive methods. Ultra-performance liquid chromatography quadrupole time-of-flight mass spectrometry (UPLC-Q-TOF-MS) techniques and partial least squares-discriminant analysis (PLS) were used to identify differential lipids. **Results:** Significant differences in skin elasticity, b* value and ITA was observed between S1 and S2 groups (p<0.05). In lipid profiling analysis, the two groups displayed a good degree of separation. There were five VIP lipids with significant differences between the two groups, including PA(20:0/22:2(13Z,16Z)) and Cer(d18:0/24:0). Lipids showed a significantly correlation with skin elasticity and ITA value (p<0.05). According to ROC analysis, the AUC values of PG(20:0/22:1(11Z)) and Cer(d18:0/24:0) are greater than 0.7. The results showed that the prediction performance of these two lipids was better and more representative than other lipids. **Conclusion:** Compared with S1 group, the facial barrier function of the volunteers in S2 group did not change significantly, indicating that the effect of sensitive skin on the skin was stronger than the change of age on the skin barrier function in a certain period of time. Significant changes in elasticity, radiance and differential lipids involved in inflammation indicate that the volunteers in S2 group had exhibited a trend of early aging along with inflammatory aging.

Keywords: Lipidomics, The Yellow Emperor Internal Classic, Sensitive skin, Skin aging, Elasticity

Introduction

The Yellow Emperor Internal Classic is the earliest medical classic in China, written from the pre-Qin to the Western Han Dynasty. As the foundation of traditional Chinese medicine, this book reflects the wisdom of ancestors on health issues with rich elaborations on life formation, diseases, health preservation, etc., and guides our life through relevant theories and experiences gained from long-term practice (Liu *et al*., 2024). According to long-term medical practice, the Yellow Emperor Internal Classic takes "seven" as the life rhythm of women, and summarizes the characteristics of the circadian rhythm of women's growth and aging. In "Suwen Ancient Innocence Treatise", it's written that "At three sevens, "Qi" in kidney is average, so the true teeth grow; at four sevens, the muscles and bones are strong, the hair is extremely long, and the body is strong; at five sevens, the Yangming pulse gets weak, the face is scorched, and the body starts declining" (Chen & Li, 2021). It means that at the

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age of 29–35, all organs of the body, mental state, psychological condition, etc. will be affected by aging. Sun *et al*. (2018) studied women's follicular fluid through metabolomics and found significant differences in hormones and phospholipids in women at different age, revealing the connotation of the "Seven Seven Theory" in the Yellow Emperor Internal Classic. There is no doubt that the skin of the human body and its appendages are also affected by the "Seven Seven Theory". In the traditional Chinese culture, it is believed that at the age of 35, the Yangming pulse began to decay. Since Yangming pulse correlates with the face and forehead, so wrinkles starts appearing on face and skin color gets gradually dark. Existing studies suggest that with age, thin epidermis and dermis layers in skin structure (Choi, 2019), decrease of Langerhans cells, and decrease of antigen-specific immunity change the immune composition of the skin (Zhang *et al*., 2019; West & Bennett, 2018). Thus, the skin barrier function is impaired, and the incidence of skin cancer and skin infections increases. However, the changes in different skin types with age are not clear, and the underlying markers of significant changes in the skin aging process remains to be identified.

Lipids are an important component of the skin barrier. In recent years, more and more studies have shown the effects of aging on the lipid composition of the skin (Choi, 2019; Chamers & Vukmanovic-Stejic, 2020), as well as on skin physiological parameters (Machková *et al*., 2018). Skin lipidomics is a part and extension of metabolomics (Raunegger *et al*., 2021), which can be used to comprehensively and systematically analyze the types and abundance of skin surface lipids (Smirnov *et al*., 2019). Our research group has established a complete set of UPLC-QTOF-MS-based sample collection, lipid extraction, data acquisition and analysis methods, and revealed the importance of lipids in skin status through the combination of lipidome with physiological indicators (Zhou *et al*., 2020a; Zhou *et al*., 2020b; Zhou *et al*., 2021).

To analyze the changes and trends of important lipid components in the aging process of facial skin in women with sensitive skin, in this study, we divided the women's age stages according to the Yellow Emperor Internal Classic, and recruited Chinese female volunteers with sensitive skin aged 22–28 and 29–35 years old. Ultra-performance liquid chromatography quadrupole time-of-flight mass spectrometry (UPLC-Q-TOF-MS) was used to systematically analyze the changes of lipid composition. Omics technology was used to analyze the clustering of facial skin lipid groups, the content and characteristics of ceramides and fatty acids. The correlation between skin aging markers and skin physiological parameters including transepidermal water loss of facial skin, skin moisture content, skin surface pH, skin elasticity, skin color, wrinkles was explored. The changes of sensitive skin lipid components in the aging process and the influence on skin physiological parameters were discussed. In summary, our study provides precise skin care theory guidance for development of cosmetics for Chinese women with sensitive skin at age stages of 22–28 and 29–35 years old.

Materials and Methods

1. Study subjects and inclusion criteria

According to the age stages of women in the Yellow Emperor Internal Classic, a total of 65 females with sensitive skin in China were recruited, including 32 subjects aged 22–28 (S1 group, average age: 23.84±1.39) and 33 subjects aged 29–35 (S2 group, average age: 31.48±1.94). Exclusion criteria were as follows: major illnesses and being treated with medication, such as heart disease, liver disease, mental illness, etc.; serious disorders of one's own endocrine system, such as diabetes mellitus; autoimmune diseases; patients who were uncooperative or did not complete required information. All volunteers were fully informed of the purpose of the experiment and signed an informed consent form. This is a non-invasive study that follows the principles of the Declaration of Helsinki.

2. Skin physiological parameters and lipid collection

Volunteers first clean their faces with water and then sit still for 30 minutes in a constant temperature (24℃) and relative humidity (50%). Considering the influence on facial lipids during the collection of physiological parameters, physiological parameters were collected after the lipid collection.

Sebutape® (purchased from CuDerm Corporation, Dallas, TX, USA) test strips were attached to the right cheek of subjects, and removed after three minutes. Subsequently, the test strips were put in sample tubes, and stored at −80℃ in the refrigerator.

Volunteer facial physiological indices were performed, including skin stratum corneum hydration (Keratometer CM 825); TEWL value (Tewameter TM 300); skin sebum (Sebumeter SM 815); skin pH (Skin pH meter 905); skin glossiness (Glossymeter

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GL200); skin melanin and red pigment (Mexameter MX 18); skin wrinkles, smoothness and roughness (Visioscan VC 98); skin elasticity (R2) (Cutometer dual MPA580); skin folds, smoothness and roughness (Visioscan VC 98).

3. Lipid extraction and sample preparation

The samples were removed from the −80℃ freezer. The lipids were extracted using the modified Bligh and Dyer method, followed by desiccation under a nitrogen blowing instrument. Finally, the lipids were reconstituted with methanol–isopropanol 1:1 v/v mixture (Zhou *et al.*, 2020a; Zhou *et al.*, 2020b; Zhou *et al.*, 2021).

4. UPLC analysis conditions

According to the laboratory's previous UPLC–QTOF–MS methodology (Wang *et al.*, 2020), the following setup was used: column, Waters UPLC CSH C18 (1.7 μm, 2.1 mm×100 mm); Phase A (acetonitrile:water=4:6; 0.1% formic acid; 10 mmol/L ammonium formate) and Phase B (acetonitrile:isopropanol=9:1; 0.1% formic acid; 10 mmol/L ammonium formate); flow rate, 0.3 mL/min; injection volume: 2.0 μL; column temperature: 50℃.

Mass spectrometry was performed in positive ion mode using electrospray ionization (ESI) with a mass spectrum scanning range of 50–1200 m/z and a carrier gas of nitrogen. Leucine enkephalins (m/z 554.2771) was used as an external marker. Data acquisition was performed using MassLynx 4.1 (Waters Corporation, Milford, USA) data management software.

5. Data analysis

The raw data was processed using Progenesis QI 2.0 software and then transferred to Ezinfo 3.0 software and SIMCA 14.1 software for principal component analysis (PCA) and orthogonal projections of latent structural discriminant analysis (OPLS-DA). Important lipids were filtered with VIP〉1, p−value〈0.05, fold change〉2. GraphPad Prism 8.0.2 was used to determine the significance of differences in biological parameters between two groups, $^{***}p$〈0.001; $^{**}p$〈0.01; $^{*}p$〈0.05. Finally, the human lipid database was used to search for these compounds and obtain the composition and information of the characterized lipids, and then the different lipids were analyzed by correlation analysis.

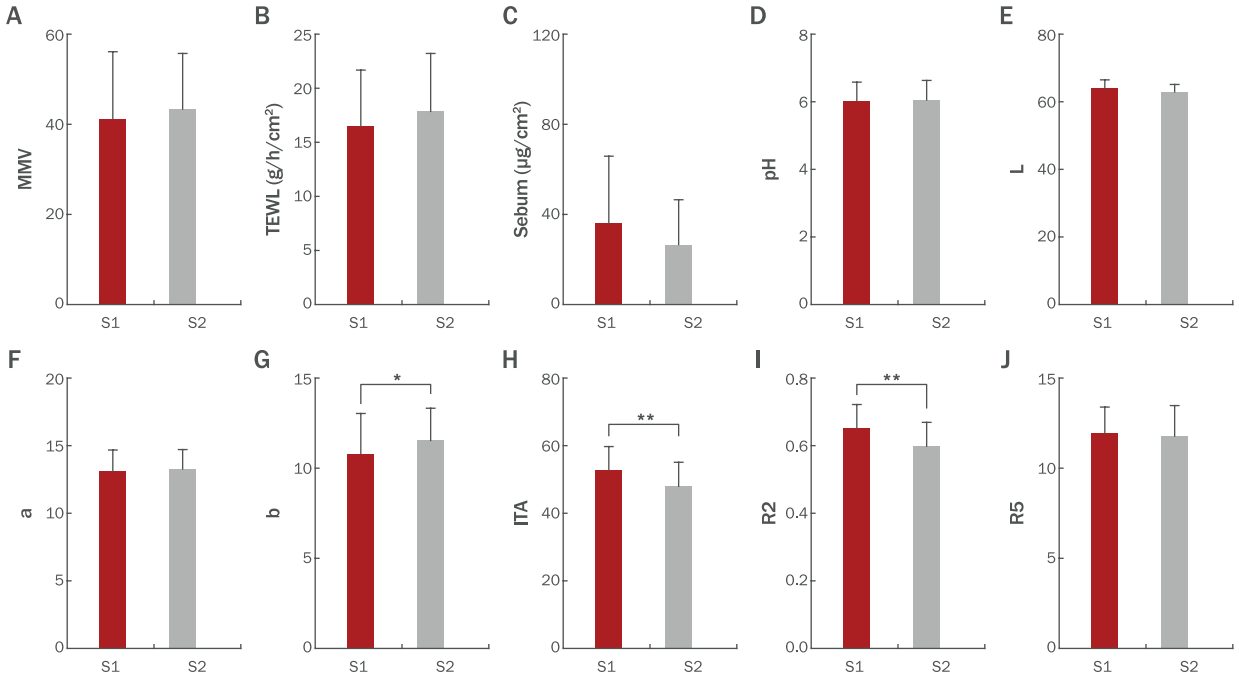

Figure 1. Physiological parameters in S1 and S2 group.
(A) skin moisture content; (B) transepidermal water loss; (C) oil content per unit area of skin; (D) pH value of the skin surface; (E) L* value; (F) a* value; (G) b* value; (H) ITA value; (I) skin elasticity R2 value; (J) R5 value for fine lines at the corners of the eyes. *p<0.05; *p<0.01.

Results

1. Effects of aging on the physiological parameters of female sensitive skin

The skin barrier-related physiological parameters including moisture content, transepidermal water loss, oil content, and pH in S1 and S2 group are shown in Figure 1. The moisture content (p=0.506) and TEWL values (p=0.284) in S2 group were higher than those in S1 group. The oil content (p=0.156) was lower in S1 group than in S2 group. The pH value (p=0.804) did not change significantly. However, no significant differences on the above four physiological parameters were detected between S1 and S2 group.

The L^* value, a^* value, and b^*value represent the black and white brightness, redness, and yellowness of skin color, respectively. The larger the L^* value, the closer it is to white; the larger the a^* value, the more red the skin tone; the higher the b^* value, the more yellow the skin tone. The ITA value indicates the individual type angle, and a larger ITA value indicates a lighter skin tone.

Among the skin color-related physiological parameters, as shown in Figure 1, there was no significant difference in L^*value (p=0.536) and a^* value (p=0.207) between two groups. The b^* value in S2 group was significantly higher compared to that of S1 group (p=0.013), while the ITA value showed opposite change (p=0.006). Thus, the skin tone of S2 group was significantly darker than that of S1 group.

Among the physiological parameters related to skin aging, as shown in Figure 1, the skin elasticity of the S2 group was significantly reduced compared with the S1 group (p=0.002). There was no significant difference in fine lines at the corners of the eyes between the two groups (p=0.613).

2. Facial lipid clustering in S1 and S2 groups

To evaluate the repeatability of the UPLC-QTOF-MS method quality control (QC) samples were analyzed. As shown in Figure 2A, QC samples clustered well, indicating stable machine performance and accurate experiments.

Following non-targeted lipidomics analysis, the OPLS-DA model was used for multivariate data analysis. The obtained model score plot is shown in Figure 2B. The difference between two groups is not significant (cumulative variance contribution rate is 31.46%, less than 50%), indicating minor difference in lipids between two groups.

After data collation of S1 and S2 groups, it was found that 605 lipids of the 917 lipids exhibited high concentration variation (the coefficient of variation CV mostly exceeded 〉100%. After filtering out these 605 lipids, 312 lipids were re-mapped (Figure 2C) and two groups separated well (cumulative variance contribution of 51.91%).

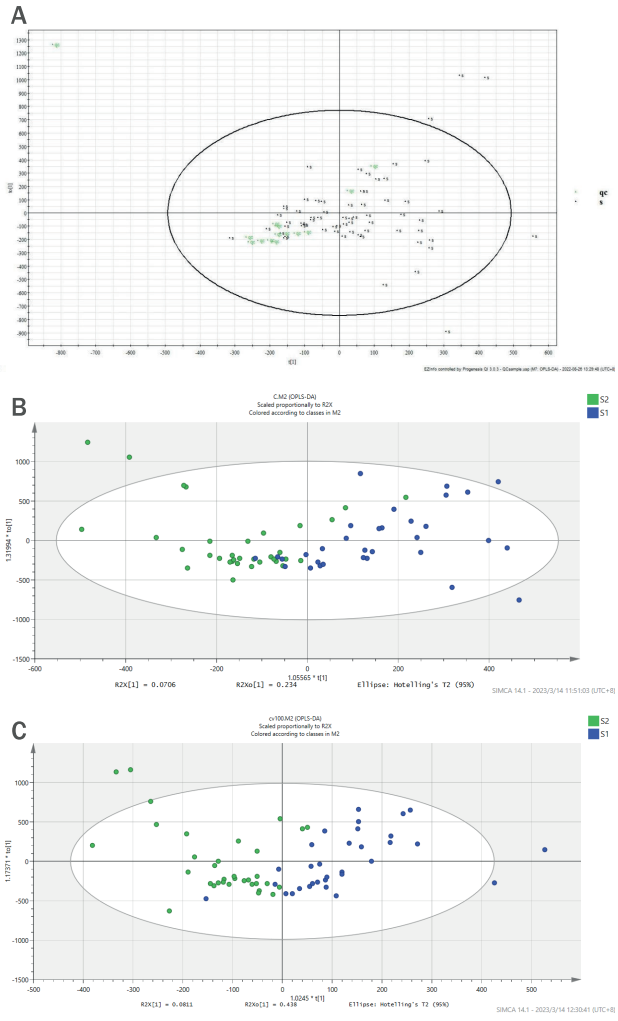

Figure 2. Scores plot of skin surface lipids.
(A) Scores diagram of QC and test samples; (B) OPLS-DA score plot; (C) After removing the lipids with CV>100, OPLS-DA score plot of skin surface lipids in S1 and S2 groups.

3. Relative abundance of facial lipids in S1 and S2 groups

The total lipid contents of the two groups was compared, and no significant difference in the relative abundance of total lipids between the two groups was found (p=0.649) (Figure 3A).

A total of 917 lipids were classified into lipid main classes, including 253 fatty acyls [FA], 113 glycerides [GL], 142 glycerophospholipids [GP], 72 polyketones [PK], 41 pregnancy esters [PR], 6 glycolipids [SL], 225 sphingolipids [SP], and 65

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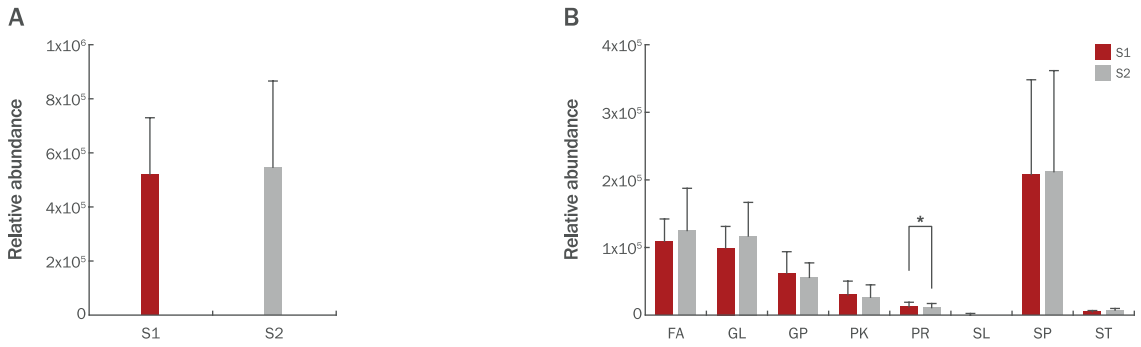

Figure 3. Relative lipid abundance.
(A) Relative lipid abundance of total lipids between S1 and S2 groups; (B) Relative abundance of eight lipids in S1 and S2 groups. FA, fatty acyls; GL, glycerides; GP, glycerophospholipids; PK, polyketones; PR, pregnenolone esters; SL, glycolipids; SP, sphingolipids; ST, sterol lipids).

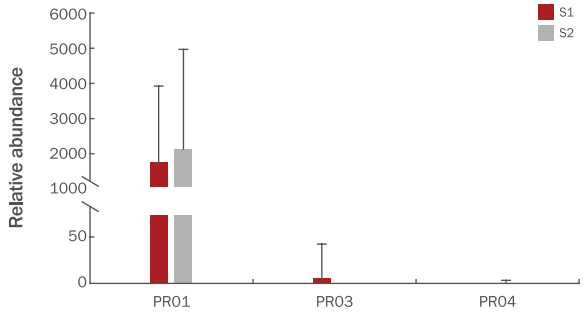

Figure 4. Relative lipid abundance plot of pregnenolone ester subclasses in S1 and S2 groups.

sterol lipids [ST]. As shown in Figure 3B, among the eight lipid classes, FA (p=0.162), GL (p=0.104), SP (p=0.940), and ST (p=0.437) in S2 group are higher than in S1 group, while GP (p=0.289), PK (p=0.526), of PR (p=0.047) and SL (p=0.530) in S2 group were lower than in S1 group. Only the relative abundance of PR was significantly different among two groups (p<0.05).

Twenty-six lipids were detected in PR class, including 24 [PR01], 1 [PR03], and 1 [PR04]. There were no significant differences in the three subclasses (p>0.05) (Figure 4).

4. Identification of differential lipid species between S1 and S2 groups

Based on the criteria of CV>100, p<0.05, Fold Change>2, VIP >1, 5 differential lipids (VIP lipids) were identified, including 1 FA, 3 GP, and 1 SP (Table 1).

5. Correlation between five VIP lipids and physiological parameters

As shown in Figure 5, 16,16-dimethyl-PGA2, PG(20:0/22:1 (11Z)), PA(20:0/22:2(13Z,16Z)) were significantly and negatively correlated with R2 and ITA values (p<0.05), PC(12:0/26:0) was significantly and negatively correlated with ITA values (p<0.05). The above four lipids were positively correlated with b^* value and displayed higher relative levels in S2 group. Cer(d18:0/24:0) with higher relative content in S1 group was positively correlated with skin elasticity R2 and ITA values. Therefore, the changes in skin elasticity and color of female sensitive skin between age of 22–28 and 29–35 may be closely related to these five lipids.

Among them, the content of Cer(d18:0/24:0) was significantly different between the two groups (Figure 6).

Table 1. Five differential lipids information

No.	Retention time (min)	m/z	Formula	Description	ANOVA (p)	Highest mean
1	8.319	725.496	$C_{22}H_{34}O_4$	16,16-dimethyl-PGA2	0.008	S2
2	10.560	818.661	$C_{46}H_{92}NO_8P$	PC(12:0/26:0)	0.002	S2
3	12.237	861.656	$C_{48}H_{93}O_{10}P$	PG(20:0/22:1(11Z))	0.002	S2
4	16.547	785.608	$C_{45}H_{85}O_8P$	PA(20:0/22:2(13Z,16Z))	0.018	S2
5	14.284	652.663	$C_{42}H_{85}NO_3$	Cer(d18:0/24:0)	0.000	S1

Table 2. AUC values of five important differential lipids

Lipid name	AUC value
16,16-dimethyl-PGA2	0.691
PC(12:0/26:0)	0.688
PG(20:0/22:1(11Z))	0.747
PA(20:0/22:2(13Z,16Z))	0.659
Cer(d18:0/24:0)	0.757

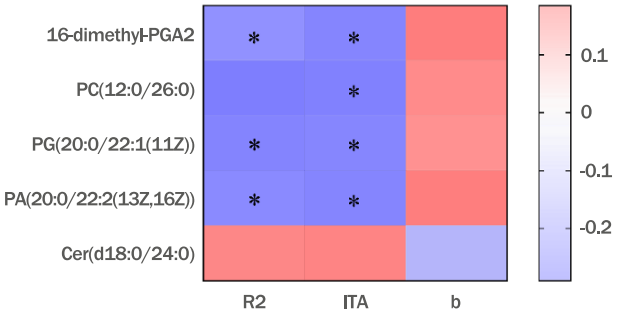

Figure 5. Correlation between important differential lipids and skin elasticity R2, ITA and b* values.
Five VIP lipids were screened using the ROC method, as shown in Table 2. The AUC values of PG(20:0/22:1(11Z)) and Cer(d18:0/24:0) were found larger than 0.7. The results show that these two lipids possess better predictive properties and more representative than other lipids.

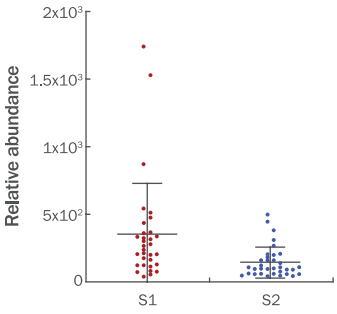

Figure 6. The relative abundance of Cer(d18:0/24:0) in two groups.

Discussion

With age, the physiological state of the skin gradually changes. Based on data from thousands, multicenter, multi-ethnic, and multi-regional studies, prior research (Flament *et al*., 2021a; Flament *et al*., 2021b; Frederic *et al*., 2020; Flament *et al*., 2018; Flament *et al*., 2020) showed that increased wrinkles are the main feature of skin aging, which seems to be associated with changes in skin structure (Kim *et al*., 2020). In our study, female volunteers aged 22–28 years versus 29–35 years with sensitive skin did not show significant facial wrinkle changes according to facial physiological parameter measurement (Figure 3B). The significant decrease in facial elasticity (Figure 3A) may be due to the decrease of skin thickness, the loss of collagen and elastin, and the skin internal structure changes with age, but it has not caused the formation of external wrinkles. These data indicate that women with sensitive skin aged 29–35 years undergo "first aging". Previous studies of facial aging in women have shown that skin radiance decreases with age (de Rigal *et al*., 2010). In our study, female volunteers with sensitive skin aged 29–35 years displayed significantly higher b* values than volunteers with sensitive skin aged 22–28 years. The value of ITA is significantly reduced in S2 group than S1 group. Among them, the b* value is related to oxidized proteins (carbonylated proteins, glycosylated proteins) (Ogura *et al*., 2011), carotenoids, etc. (Whitehead *et al*., 2012). The increase in b* value and the decrease in ITA value also showed the initial aging characteristics of gradually dull skin in women with sensitive skin aged 29–35 years.

It is important to note that our results differ from previous studies (Kim *et al*., 2019) in terms of skin barrier physiological parameters such as skin moisture content, transepidermal water dispersion, oil content, and pH. Kim *et al*. (2019) compared the physiological parameters of the skin barrier in healthy Chinese women at different ages, and concluded that the skin TEWL value and oil content decreased significantly with age ($p<0.05$). Similar results were obtained by Luebberding *et al*. (2013) and Zhao *et al*. (2021). However, in our study, the increasing age of women with sensitive skin did not result in significant changes in physiological parameters related to the skin barrier. We speculate that this may be due to the fact that sensitive skin has been accompanied by impaired skin barrier, reduced water content, and elevated TEWL values (McCormick *et al*., 2023; Anqi *et al*., 2022), and the effect of sensitive skin on the skin is stronger for

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a certain period of time than the change of skin barrier function by age. This needs to be proven by follow-up studies.

Lipid clustering showed that the facial lipids of the S1 and S2 groups had a good differentiation. In the analysis of lipid main classes, only pregnenolone esters exhibited significant differences. Pregnenolone lipids and their phosphorylated derivatives play an important role in the transport of oligosaccharides between cell membranes, and their derivatives have been shown to possess anti-inflammatory activity (Cai *et al.*, 2021). Pregnenolone is also a hormone involved in the production of steroid hormones such as progesterone, mineralocorticoids, glucocorticoids, androgens, and estrogens (Rogers *et al.*, 2012). The total facial pregnenol lipids in S2 group were significantly lower than those in S1 group, suggesting increasing facial inflammation and hormonal changes with age.

Combining the analysis of lipid classes and subclasses, we did not find lipid classes with significant differences. However, lipid subclasses with significant differences were found in lipid classes without significant differences, such as FA03 in S2 group than that in S1 group (p=0.044), when all lipid subclasses were combined. This means that the facial lipids of the subjects in S1 and S2 groups were not distinguished in main class, but there were significant differences in the subclass of the same main class (such as fatty acyls, sphingolipids, etc.). This is also confirmed by the study of VIP lipids. Among the screened VIP lipids, Cer(d18:0/24:0) content was higher in S1 group than in S2 group (Figure 6), which might be due to various factors such as the differentiation of skin keratinocytes and the sphingomyelin content. Previous study found that the expression level of keratinocytes in healthy subjects is often higher than that of psoriasis patients (Yokose *et al.*, 2020). In a screening study of facial lipid markers in women with sensitive skin, Cer(d18:0/24:0) was more likely to occur in women with non-sensitive skin (Nakatsuji *et al.*, 2016). This phenomenon possibly relates to the fact that formation of an epidermal lipid barrier contributes to its anti-inflammatory properties, suggesting that inflammation occurs in skin with age, which further increases sensitivity.

When an inflammatory response occurs in the skin, ceramide lipid (sphingolipids) contents reduced (Gruber *et al.*, 2020). Ceramides are mainly produced from glucosylceramide catalyzed by the lysosomal enzyme glucocerebrosidase-1 (GCase). GCase is mainly regulated by exosome proliferator-activated receptor signaling pathways (PPARs), which promote the secretion of lipid components of the skin, including the formation and secretion of epidermal lipids and lamellar bodies, and enhances the activity of lipid-related metabolic enzymes (Hamilton *et al.*, 2018). Studies have confirmed that activated PPARs inhibit the release of inflammatory factors and the differentiation of inflammatory cells and reduce UV-induced skin inflammation (Aioi, 2020). The reduction of facial ceramides in volunteers in the S2 group indicates that the inflammatory response occurs at all times in the process of skin aging, which is also consistent with the study of inflammatory aging of the skin (Jarrold *et al.*, 2022; Chen *et al.*, 2022).

Combined with the correlation analysis of VIP lipids and physiological parameters (b^* value, ITA value, R2), PG(20:0/22:1(11Z)), PA(20:0/22:2(13Z,16Z)), PC(12:0/26:0) are phosphatidylglycerol, glycerophosphatidic acid, phosphatidylcholine, respectively, all of which belong to the glycerophospholipid compounds. A previous study investigating serum glycerophospholipid profile and aging-related changes in mice (Kim *et al.*, 2014), showed that changes in glycerophospholipids are associated with aging and phosphatidylcholine content was higher in the older group, which is consistent with our findings. In addition, 16,16-dimethyl-PGA2 is a lipid-derived signaling molecule produced by arachidonic acid via cyclooxygenase, which inhibits collagen production and induces fibroblast expression of matrix metalloproteinase 1 (MMP1) *in vitro* (Shim, 2019). PGA2-induced inhibition of collagen expression and MMP1 promotion are aging mechanisms. Therefore, its expression was higher in S2 group, and there was a significantly and negatively correlation with R2 and ITA values.

Conclusion

Compared with the skin of volunteer aged 22–28 years, the skin of volunteer aged 29–35 years is characterized early aging in skin physiological parameters and facial lipids, and this aging is accompanied by inflammatory response. Our research provides new clues for preventing and treating sensitive skin aging. However, there are certain limitations in this study. For example, volunteers with non-sensitive skin were not included, and the sample size was relatively small. Therefore, more comprehensive and in-depth research is required to elaborate the mechanism underlying aging in sensitive skin.

Author's contribution

RT primarily conducted the experiments, performed data analysis, and wrote the manuscript. XY contributed to experimental design, carried out experiments, and assisted in data processing. PX participated in manuscript writing and material collection. HL and YF supervised the research direction and provided key experimental materials. CH, HH, and YJ oversaw the experimental design, participated in manuscript revision and finalization, and critically reviewed the research findings. All authors discussed the results, reviewed the final manuscript, and approved the submitted version.

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국문초록

《황제내경》의 여성 생활리듬에 따른 22–28세, 29–35세 중국 여성의 민감성 피부 노화에 대한 지질체학 분석

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목적: 피부 노화로 인해 민감한 피부의 얼굴 생리학적 매개 변수와 지질의 차이를 확인하고자 한다. **방법:** 민감성 피부를 가진 여성 지원자를 모집하여 S1 그룹(22–28세)과 S2 그룹(29–35세)으로 구분하였다. 피부 표면 지질 샘플과 생리학적 매개변수는 비침습적 방법으로 수집하였고, 초고성능 액체 크로마토그래피 4중극자 비행 시간 질량 분석법(UPLC–Q–TOF–MS)과 부분 최소 제곱 판별 분석(PLS)을 사용하여 차등 지질을 식별하였다. **결과:** S1군과 S2군 사이에 피부탄력, b^* 값, ITA에서 유의한 차이가 관찰되었다($p<0.05$). 지질 질량분석에서 두 그룹은 양호한 수준의 분리를 나타냈다. PA(20:0/22:2(13Z,16Z)) 및 Cer(d18:0/24:0)를 포함하여 두 그룹 간에 유의미한 차이가 있는 5개의 VIP 지질을 확인하였다. 지질은 피부 탄력도와 ITA 수치와 유의한 상관관계를 보였다($p<0.05$). ROC 분석에 따르면 PG(20:0/22:1(11Z))와 Cer(d18:0/24:0)의 AUC 값이 0.7보다 크다. 이 두 지질의 예측 성능이 다른 지질보다 우수하고 대표성이 있음을 보여주었다. **결론:** S1군과 비교하여 S2군 지원자들의 얼굴 장벽 기능은 큰 변화가 없었으며, 이는 특정 기간 동안 민감성 피부가 피부에 미치는 영향이 연령 변화보다 피부 장벽 기능에 더 강한 것으로 나타났다. 염증과 관련된 탄력성, 윤기 및 차등 지질의 유의한 변화는 S2 그룹의 지원자들이 염증성 노화와 함께 조기 노화 경향을 나타냈다.

핵심어: 지질체학, 황제내경, 민감피부, 피부노화, 탄력

中文摘要

根据《黄帝内经》女性生命节律划分的22-28岁和29-35岁中国女性敏感性皮肤衰老的脂质组学分析

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目的： 探究敏感性皮肤面部生理参数及脂质因皮肤老化而产生的差异。**方法：** 招募敏感性皮肤的女性志愿者，将其分为S1组(22-28 岁)和S2组(29-35 岁)。通过非侵入性方法采集皮肤表面脂质样本和生理参数。采用超高效液相色谱四极杆飞行时间质谱(UPLC-Q-TOF-MS)技术和偏最小二乘判别分析(PLS)来鉴定差异脂质。**结果：** S1组和S2组在皮肤弹性、b^*值和ITA值方面存在显著差异(p<0.05)。在脂质谱分析中，两组显示出良好的分离度。两组间存在五个具有显著差异的VIP脂质，包括PA(20∶0/22∶2(13Z,16Z))和Cer(d18∶0/24∶0)。脂质与皮肤弹性和ITA值显著相关(p<0.05)。根据ROC分析，PG(20∶0/22∶1(11Z))和Cer(d18∶0/24∶0)的AUC值大于0.7。结果表明，这两种脂质的预测性能优于其他脂质，且更具代表性。**结论：** 与S1组相比，S2组志愿者的面部屏障功能未发生显著变化，这表明在一定时期内，敏感性皮肤对皮肤的影响比年龄变化对皮肤屏障功能的影响更强。弹性、光泽度以及与炎症相关的差异脂质的显著变化表明，S2组志愿者出现了早期衰老以及炎症性衰老的趋势。

关键词： 脂质组学，黄帝内经，敏感性皮肤，皮肤衰老，弹性

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