Introduction

Aging is a major cause of many degenerative diseases. Genomic instability, mitochondrial dysfunction, deregulated nutrient sensing, loss of proteostasis, epigenetic alterations, cellular senescence, stem cell exhaustion, altered intracellular communication, and telomere attrition are the nine hallmarks of aging (López-Otin et al., 2013). Skin is the largest organ...
in the body and plays a critical role in protecting us from the environment. Like other organs, skin is affected by both intrinsic aging and environmental factors that accelerate aging. Aging skin undergoes structural, cellular, and molecular changes and accumulation of senescent cells, which are manifested by increased wrinkles, sagging, reduced elasticity, capillary dilation, and abnormal skin pigmentation (Franco et al., 2022).

Although aging is a highly complex and not yet fully understood process, the human life rhythm was proposed in the ancient Chinese medicine book Huangdi Neijing more than 2000 years ago. Huangdi Neijing is a comprehensive medical text, which is derived from the ancient Chinese people’s long-term observation of the phenomena of life, extensive clinical practice, and simple anatomical knowledge. The book laid the foundation for the understanding of human physiology, pathology, diagnosis and treatment, and is regarded as the originator of medicine (Yang, 2004). Based on the mathematical model of “Luoshu Jiugong Bagua”, the thinking method of analogy and astronomical knowledge, Huangdi Neijing proposed that male and female grow and develop in periods of eight and seven years, respectively (Peng et al., 2017). According to this principle, female body reaches its optimal state between the age of 22 to 28 (the third seven years), and starts aging, become dullness and lose hair between the age of 29 to 35 (the fourth seven years). Therefore, these rhythms are important to manage the aging process (Nian et al., 1993).

The metabolomics of serum and urine samples from volunteers of different age groups divided based on life rhythm theory in Huangdi Neijing was analyzed by UPLC-QTOF-MS (Chen et al., 2020), and significant differences in metabolic patterns between different age groups were observed, thus providing primary evidence for the theory of “Female Seven Male Eight” life rhythm.

The metabolomic changes in skin aging process described in Huangdi Neijing have not been studied. Further studies could help to identify new biomarkers of skin aging. Lipidomics is a high-throughput technique with powerful analytical capabilities to determine skin lipid composition. Mining lipidomics data under different skin physiological state can help to decipher the mechanisms by which skin lipids influence skin conditions (Jia et al., 2018).

Based on UPLC-QTOF-MS, we have established a set of skin surface lipid research methods and optimized the workflow of sample collection, extraction and data analysis. So far, we have investigated lipid changes in different skin states, including SSL differences between males and females (Cui et al., 2018), SSL changes in sensitive skin caused by psychological stress (Jiang et al., 2019), SSL changes between atop dermatitis and healthy infants (Wang et al., 2020), lipidomic changes in circadian rhythms (Jia et al., 2019), and lipid differences between acne and healthy infants (Yang et al., 2021).

In this study, we performed skin surface lipid analysis on oily skin of Chinese female at two developmental stages defined by the seven-year rhythm. The association between differential lipids and skin physiological parameters was further analyzed, and the potential mechanisms of differential lipids affecting skin aging were discussed.

**Materials and Methods**

1. **Study subjects**

A total of 62 female subjects with oily skin type from Beijing, China were enrolled in the current study, including 32 subjects at age of 22–28 (group O1, mean age 24.44±1.90) and 30 subjects at age of 29–35 (group O2, mean age 32.33±1.86). All participants were not pregnant, breastfeeding, menstruating, taking any medication within the last three months, and were not smokers and alcohol addict. All subjects signed an informed consent form.

2. **Skin biophysical parameter measurement**

Skin water content, transdermal water loss, pH, oil and moisture were measured using Corneometer® CM 825, TM300, PH905, Sebumeter SM815, CL 400 (Courage+Khazaka Electronic), respectively. Cutometer MPA580 was employed to measure skin elasticity. Skin color was determined by GmbH Colorimeter (Courage+Khazaka Electronic). All measurements were taken on the right cheek. Periocular images were acquired using VISIA®-CR, and wrinkle area analysis was performed using Derma Top.

3. **Sample Collection and Preparation**

Participants cleaned their face with water, followed by sitting in standard conditions with a constant temperature of 21±2°C and a constant relative humidity of 50±10% for 30 min. A Sebutape® strip was applied on the right cheek of each subject and then removed after 3 min. The samples were stored at −80°C until further analysis.

Lipids absorbed to the strip were extracted using the modified Bligh and Dyer method. The samples were removed from the
4. UPLC analysis

The mobile phases consisted of phase A (acetonitrile and water mixed in a 2:3 v/v ratio, containing formic acid and ammonium formate) and phase B (acetonitrile and isopropanol mixed in a 9:1 v/v ratio, containing formic acid and ammonium formate). The gradient elution programme was as follows: 0–1 min, 60% A; 16–18 min, 0% A; 20.1–22 min, 60% A at a flow rate of 0.4 mL/min. The injection volume was 6 μL and the column temperature was 60°C.

5. Mass spectrometry analysis

Lipid acquisition was performed in positive ion mode using an electrospray ionization source (ESI) with a mass scan range of 50 to 1200 m/z. Nitrogen gas was used in each gas path. Leucine enkephalin (m/z 554.2771) was used as an external standard for calibration. Data were collected using Masslynx 4.1 software (Waters Corporation, USA). Other parameters were set as follows: capillary voltage of 3200 V (+)/2500 V (−), cone well voltage of 35 V, adsorbent gas temperature of 400°C, desolvation gas at flow rate of 800 L/h and ion source temperature of 120°C.

6. Data collection and statistical analysis

Raw data were acquired by MassLynx4.1 software, and the data were processed using Waters Progenesis QI V2.0 (Waters Corporation) and Ezinfo 3.0 software (Waters Corporation). Firstly, the collected raw data were imported into QI software for peak extraction and alignment. The resulting compound information was imported into Ezinfo software. The score plot of the Orthogonal Partial Least Squares Discriminant Analysis (OPLS–DA) model was used to examine whether there was a significant difference between the two groups. Independent sample t-test and non-parametric test ("p<0.05, "p<0.01) were used for significant statistical analysis and screening for differential lipids by "p<0.05, Fold Change>2, VIP>1. The ROC curve with AUC value>0.9 was used to screen out the lipids associated with the physiological parameters.

Results and Discussion

1. Aging–related characteristics such as loss of skin elasticity and color changes are consistent with the description in Huangdi Neijing

Skin wrinkles, spots, color, elasticity, and stratum corneum hydration are important indicators of skin aging (Yonei et al., 2016). Stratum corneum hydration, transdermal water loss, oil content, pH, skin elasticity, eye wrinkles, L*a*b* values, and ITA of all subjects were measured. No significant difference (p>0.05) was observed between the O1 and O2 groups for the four parameters relating to barrier function (hydration, transdermal water loss, oil content, and pH). In contrast, skin elasticity and radiance were significantly different between two groups, with the O2 group exhibiting decreased elasticity and dull skin. This is consistent with the description in Huangdi Neijing that the growth and development of the human body culminates at the age of 22–28, with strong muscles, bones, and luxuriant hair, whereas at the age of 29–35, the supply of “Qi” and “Blood” is deficient, resulting in an aging stage with dull skin.

1) Significant decrease in skin elasticity in O2 group

Skin elasticity and wrinkles around the eyes are important features of skin aging. Based on the questionnaire survey (Appendix: Questionnaire survey on skin aging) completed by the subjects, Both the O1 and O2 groups were concerned about the anti-aging of fine lines around the eyes, with the O2 group focusing more on anti-aging. No significant difference was observed between the two groups for fine lines around eyes (p=0.3066), while skin elasticity was significantly lower in the O2 group than in the O1 group (p=0.0018) (Figure 1).

![Figure 1. Skin elasticity and wrinkle in the O1 and O2 groups.](http://www.e-sjbc.org)

(A) Skin elasticity; (B) Wrinkles at the corners of the eyes. ns, not significant; "p<0.01.
2) Dull and yellow skin tone in O2 group

Lab value and ITA value are commonly used to evaluate skin color. L-value, a-value, and b-value represent the black and white brightness, redness, and yellowness of skin color, respectively. The ITA value represents the individual typological angle (ITA) and a higher ITA value indicates a lighter skin tone. In Figure 2, two age groups showed significant changes in skin glossiness, with significant differences in b-value ($p=0.0260$) and ITA values ($p=0.0053$). The O2 group exhibited a duller and yellower skin tone compared to the O1 group.

2. Significant changes in seven main lipid classes between O1 and O2 groups

The Lipid Metabolites and Pathways Strategy (LIPID MAPS) classifies lipids into eight main classes: fatty acyl (FA), glycerolipids (GL), glycerophospholipids (GP), sphingolipids (SP), sterol lipids (ST), prenol lipids (PR), saccharo lipids (SL) and polyketides (PK). A total of 1453 lipids were identified by UPLC-QTOF–MS analysis and lipid mapping (http://www.lipidmaps.org/). As shown in Figure 3, seven lipid main classes including [FA], [GL], [GP], [PK], [PR], [SP], and [ST] showed significant changes ($p<0.05$), with higher relative levels in the O2 group.
3. Nineteen individual lipid species were the most critical entities accountable for the variances between SSL from two groups

The obtained lipids were compared with the Lipid Maps database. With screening criteria of \( p < 0.05 \), Fold Change > 2, and VIP > 1, the OPLS–DA model was used to screen for lipids with significant differences between the O1 and O2 groups. As is shown in Table 1, 25 differential lipids belonging to [FA], [GL], [GP], [PK], [SP], and [ST] classes were identified. Among them, 19 lipid species showing the same trend of change as the subclasses they belonged to were selected as VIP lipids, including [FA01], [FA07], [FA08], [FA13], [GL02], [GL03], [GP03], [GP06], [PK12], [SP01], [ST04].

4. Seven VIP lipids were significantly and negatively correlated with skin elasticity and glossiness

The association between 19 VIP lipids and two physiological parameters R2 and ITA, which were significantly different between two groups was further investigated. The correlation heat map in Figure 4 showed that 12 VIP lipids were significantly correlated with skin elasticity R2 and ITA values.

ROC curves with AUC values > 0.9 were further used to identify lipids that showed significant negative correlation with R2 and ITA values. Seven lipids were identified, including myriocin (LMFA01060203), erucamide (LMFA01060203), GL02 (O-16:0/22:1(11Z)) (LMGP03020015), PK12 (O-18:0/17:0) (LMGP03020024), cyanidin 3-(6''-sinapylsophoroside)-5-glucone (LMPK12010178), C16 sphinganine (LMSP01040001) (Figure 5). Furthermore, the relative levels of the above lipids were higher in the O2 group than in the O1 group. Therefore, the discrimination in elasticity

<p>| Table 1. The most important lipids accountable for the variances between SSL from two groups |
|----------------------------------------|----------------|---------------|--------|-------|-----------------|</p>
<table>
<thead>
<tr>
<th>Description</th>
<th>Formula</th>
<th>Retention time (min)</th>
<th>m/z</th>
<th>p-values</th>
<th>Highest mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lanoceric acid</td>
<td>C₃₀H₆₀O₄</td>
<td>14.2567</td>
<td>507.4405</td>
<td>0.0015</td>
<td>O2</td>
</tr>
<tr>
<td>Myriocin</td>
<td>C₁₂H₁₈NO₆</td>
<td>1.0329</td>
<td>402.2847</td>
<td>0.0000</td>
<td>O2</td>
</tr>
<tr>
<td>FAHFA(15:0/6-0-18:0)</td>
<td>C₁₂H₄₀O₆</td>
<td>14.814</td>
<td>547.4718</td>
<td>0.0032</td>
<td>O2</td>
</tr>
<tr>
<td>Eruamide</td>
<td>C₁₂H₂₀NO₇</td>
<td>3.4313</td>
<td>338.3409</td>
<td>0.0000</td>
<td>O2</td>
</tr>
<tr>
<td>bhas#38</td>
<td>C₂₇H₅₂O₇</td>
<td>2.2391</td>
<td>489.3787</td>
<td>0.0029</td>
<td>O2</td>
</tr>
<tr>
<td>1-(14-methyl-pentadecanoyl)-2-(8-3-ladderane-octanoyl)-sn-glycerol</td>
<td>C₃₉H₷₀O₄</td>
<td>3.3456</td>
<td>603.5353</td>
<td>0.0017</td>
<td>O2</td>
</tr>
<tr>
<td>TG(16:1(9Z)/17:2(9Z,12Z)/17:2(9Z,12Z))[iso3]</td>
<td>C₅₃H₹₂O₆</td>
<td>15.5065</td>
<td>825.7006</td>
<td>0.0002</td>
<td>O2</td>
</tr>
<tr>
<td>PS(17:0/21:0)</td>
<td>C₁₄H₵NO₉</td>
<td>14.7066</td>
<td>797.6681</td>
<td>0.0030</td>
<td>O2</td>
</tr>
<tr>
<td>PS(0-16:0/22:1(11Z))</td>
<td>C₁₄H₵NO₉P</td>
<td>7.9696</td>
<td>804.6082</td>
<td>0.0000</td>
<td>O2</td>
</tr>
<tr>
<td>PS(0-18:0/17:0)</td>
<td>C₁₄H₵NO₉P</td>
<td>7.9696</td>
<td>764.5766</td>
<td>0.0000</td>
<td>O2</td>
</tr>
<tr>
<td>PI(12:0/22:4(7Z,10Z,13Z,16Z))</td>
<td>C₁₄H₵NO₉</td>
<td>10.3031</td>
<td>758.2238</td>
<td>0.0016</td>
<td>O2</td>
</tr>
<tr>
<td>Pelargonidin 3-gentiobioside</td>
<td>C₃₃H₴₁O₁₀</td>
<td>12.8653</td>
<td>980.2813</td>
<td>0.0191</td>
<td>O2</td>
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<tr>
<td>Alatanin 2</td>
<td>C₁₄H₵NO₉</td>
<td>11.2665</td>
<td>832.2429</td>
<td>0.0002</td>
<td>O2</td>
</tr>
<tr>
<td>C₁₆ sphinganine</td>
<td>C₁₄H₵NO₉</td>
<td>0.8405</td>
<td>274.2730</td>
<td>0.0000</td>
<td>O2</td>
</tr>
<tr>
<td>Cer(d₁₈:0/16:0)</td>
<td>C₁₄H₵NO₉</td>
<td>6.3569</td>
<td>540.5345</td>
<td>0.0000</td>
<td>O1</td>
</tr>
<tr>
<td>Cer(d₁₈:0/18:0)</td>
<td>C₁₄H₵NO₉</td>
<td>8.8760</td>
<td>568.5656</td>
<td>0.0000</td>
<td>O2</td>
</tr>
<tr>
<td>Cer(d₁₈:0/14:0)</td>
<td>C₁₄H₵NO₉</td>
<td>5.0932</td>
<td>512.5027</td>
<td>0.0000</td>
<td>O2</td>
</tr>
<tr>
<td>Cer(d₁₈:0/30:0(30OH))</td>
<td>C₁₄H₵NO₉</td>
<td>14.8351</td>
<td>752.7482</td>
<td>0.0001</td>
<td>O2</td>
</tr>
<tr>
<td>Cer(d₁₈:0/31:0(31OH))</td>
<td>C₁₄H₵NO₉</td>
<td>15.2630</td>
<td>766.7617</td>
<td>0.0202</td>
<td>O2</td>
</tr>
<tr>
<td>Cer(1₈:0/19:0)</td>
<td>C₁₄H₵NO₉</td>
<td>9.7824</td>
<td>598.5778</td>
<td>0.0009</td>
<td>O1</td>
</tr>
<tr>
<td>3alpha-hydroxy-6-oxo-5beta-chol-24-oic acid</td>
<td>C₉₄H₴₄O₄</td>
<td>2.8956</td>
<td>391.2831</td>
<td>0.0011</td>
<td>O2</td>
</tr>
</tbody>
</table>
and color of oily skin among 22–28 and 29–35 age groups may be closely related to the above seven lipids.

5. Lipid analysis correlated to R2 and ITA

1) Myriocin

Myriocin (Myr) plays an important role in regulating lipid metabolism (Wadsworth et al., 2013; Yang et al., 2019; Wang et al., 2022), restoring cellular autophagy, regulating the aging process (Fan et al., 2018; Liu et al., 2013), alleviating chronic inflammation (Wang et al., 2022), and anti-glycation (He et al., 2022; Alka et al., 2022). In the present study, Myr exhibited a significant negative correlation with R2 and ITA values. Increase levels of Myr may help the skin to resist external stress and the adverse effects caused by natural aging. It might be a manifestation of the body's self-regulation to maintain normal physiological functions. The high relative level of Myr in skin may be a potential marker of the aging stage.

2) Erucamide

Psychological stress triggers a wide range of physiological and behavioral changes and responses, with the skin being both a direct receptor of stress and a target of the stress response (Chen et al., 2014; Papadimitriou et al., 2009). Topical use of beta-blockers such as timolol, angiotensin receptor blockers such as valsartan, glucocorticoid blockers such as mefepristone, and cholinergic modulators such as botulinum toxin may be potential therapeutic strategies to prevent skin aging (Dunn et al., 2013).

Erucamide (ERA) is a biologically active fatty acid amide that inhibits the activity of acetylcholinesterase (ACHE) and regulates physiological functions in a receptor-mediated manner (Kallingal et al., 2022). Studies have revealed the antidepressant and anxiolytic effects of ERA (Li et al., 2017). In addition, ERA also modulates cholinergic function and has dose-dependent angiogenic effects (Kim et al., 2018; Mitchell et al., 1996). As emotional skin care becomes more widespread, the increase of ERA in the O2 group, which can relieve mental stress and regulate choline function, may be the feedback on the skin after the body perceives mental, physical, or emotional stress. Our results indicate that ERA may potentially act as a marker of skin aging due to mental stress.

3) Phosphatidylserine

Phosphatidylserine (PS) is not only a component of cell membranes, but also a signaling molecule in many pathways (Leventis et al., 2010; Kay et al., 2013; Segawa et al., 2015). Importantly, previous studies suggest that PS can increase procollagen synthesis, inhibit MMP-1 expression and activity by downregulating the MAPKs/AP-1 signaling pathway and exert anti-photoaging effects (Lee et al., 2013; Lim et al., 2022; Cho et al., 2008). In the current study, the relative content of PS in the facial skin increased in the older O2 group. This finding is consistent with the report by Cho et al., showing increased PS synthesis in the cerebral cortex and cerebellum of aged rats (Cho et al., 2008). PS is necessary for maintaining skin elasticity. However the function of PS in skin color change remains unknown and requires further investigation.

4) Flavonoids

Cyanidin3-6′-sinapylsophoroside)-5-glucoside belongs to the anthocyanidins subclass of flavonoids. Flavonoids possess a variety of biological activities, including anti-oxidant,
anti-melanogenic (Kim et al., 2022), anti-glycation, anti-inflammatory, antibacterial, and cyto-protective effects (Cazarolli et al., 2008). They can modulate cellular processes such as senescence and senescence-associated secretory phenotypes, thereby delaying skin appearance and functional aging (Khoo et al., 2017; Domasewska-Szostek et al., 2021).

Tyrosinase is a key enzyme for hair and skin pigmentation, Natural products such as flavonoids are natural potent tyrosinase inhibitors. In previous studies, Duku (Lansium domesticum Corr.) extracts, which are rich in flavonoids and vitamins, effectively protected the skin from sun exposure and reduced melanin pigmentation (Maretha et al., 2022). In addition to melanin deposition, non-enzymatic glycation of proteins can produce advanced glycation end products (AGEs) and important intermediates (α-dicarbonyl compounds, such as methylglyoxal), which are associated with diabetic complications as well as skin dullness. Different A-type proanthocyanidins effectively inhibited protein glycosylation and potentially reduced the harmful effects of glycation products on the organism (Zhao et al., 2022), Citrus flavonoids are known for their antioxidant and anti-inflammatory properties and often applied in the prevention of skin aging/photoaging, skin pigmentation (Sebghatollahi et al., 2022).

Although flavonoids have been widely used in cosmetics, research on cyanidin3-(6''-sinapylsophoroside)-5-glucoside is still lacking. Based on the bioactive properties of flavonoids, negative correlation between cyanidin3-(6''-sinapylsophoroside)-5-glucoside and R2, ITA, as well as its increased relative content in O2 group, cyanidin3-(6''-sinapylsophoroside)-5-glucoside may be a potential chemical for maintaining or improving skin elasticity and coloration, 5) Sphinganine

Sphinganine is an essential structural component of the plasma membrane and a critical mediator in various intracellular signaling pathways, such as cell proliferation, differentiation, apoptosis, inflammation, migration, cellular stress responses, endoplasmic reticulum stress, and other fundamental processes (Park et al., 2020).

Sphingolipids can promote keratinocyte differentiation and ceramide production (Paragh et al., 2008; Sigruener et al., 2013), and play an essential role in skin barrier function. Studies have shown that the levels of sphingosine and sphinganine are significantly higher in the lesional epidermis of psoriasis patients than in the non-lesional epidermis (Moon et al., 2013). Sphingosine regulates genes related to differentiation and sphingolipid metabolism and also increases levels of all major ceramide species, with a specific increase in very long-chain ceramides that are essential for intact barrier function. Free sphingosine can be used as raw materials in skin and hair care applications. In addition, dietary supplementation of glucosylceramide and sphingomyelin significantly upregulated the expression of ceramide synthase 3 and 4 in the epidermis of an atopic dermatitis-like skin model and accelerated the recovery of damaged skin barrier function (Duan et al., 2012).

As the skin barrier function gradually declines with age, the increase level of sphingolipids in O2 group might be vital for maintaining the structure and function of the skin barrier. Sphingolipids may regulate other lipid components indirectly, thereby influencing skin elasticity and skin dullness,

Conclusion

The findings of this study are consistent with the aging pattern of female described in Huangdi Neijing, in which female body reaches its optimum state between age of 22–28 and gradually starts aging between age of 29–35. As body functions decline, skin starts to dull,

The seven lipids that are closely related to skin elasticity and tone in this study may play a crucial role in human aging by regulating gene expression, improving mitochondrial dysfunction, regulating cellular senescence, altering intracellular communication and other features of aging, maintaining the skin barrier, promoting collagen synthesis, improving skin damage from emotional stress external environmental stress, enhancing cellular autophagy, and acting directly on aging-related biological processes, Myr inhibits the activity of serine palmitoyltransferase (SPT), the first rate-limiting enzyme in sphingolipid synthesis, Sphinganine plays essential roles in a complex interrelated sphingolipid metabolic pathway by affecting ceramide synthesis. Additionally, Myr, phosphatidylserine, and flavonoids are potential molecules to regulate aging-related cellular processes and delay aging. Myr plays a vital role in improving lipid metabolism and restoring cellular autophagy and may be a potential component to target the cellular autophagy pathway to slow skin aging, ERA potentially relieve mental stress and regulate choline function, Phosphatidylserine can increase
collagen synthesis and play an essential role in skin elasticity improvement. Besides their anti-oxidant, anti-inflammatory and anti-bacterial properties, flavonoids function in anti-melanogenesis and anti-glycation to improve dull skin tone. Flavonoids have been widely used in cosmetics, but cyanidin3-(6'–sinapylsophoroside)-5–glucoside has rarely been reported, and further research remains to be carried out. Sphinganine functions in maintaining skin barrier, and the supplementation of sphingolipids is important for the stability of skin condition and function (Figure 6). Among these lipids, Myr and ERA have limited literature regarding their relevance to skin, and their functions are speculated based on some experimental literature (animal experiments) (Yang et al., 2019; Dunn et al., 2013; Li et al., 2017). It is noted that their mode of action does not primarily involve the skin. Phosphatidylserine, flavonoids, and sphinganine have been more extensively researched compared to the former, and they have been demonstrated to be applicable to the skin surface through human experiments or have been observed to affect fibroblasts and keratinocytes in cellular experiments (Cho et al., 2008; Domaszewska–Szostek et al., 2021; Sigruener et al., 2013).

In this study, the relative levels of the above seven lipids were higher in O2 group than O1 group and exhibited a significant negative correlation with R2 and ITA values. This observation suggests that the above lipids may help to resist external stresses and the adverse effects of natural aging, as the body functions decline with age. Their increased relative levels manifest the body’s self-regulation mechanisms to maintain normal physiological functions. Further investigation on these specific lipids is important for understanding the human aging process, identifying potential markers of natural aging in healthy women, and developing anti-aging cosmetic products. However, since the research on the precise structure of lipid metabolic pathways remains incomplete, this paper only...
focuses on analyzing the biochemical functions of certain types of lipids. Targeted lipidomics should be conducted to validate these findings, while the functions of the seven differential lipids should be investigated through biological experiments or human efficacy assessments. With the development of technology and the deepening of scientific research, studying metabolic pathways and biochemical processes of specific lipid components will become more in-depth, guiding us to better understand the correlation between lipids and skin changes.

**Author’s contribution**

YS participated in experimental implementation and drafted the manuscript, WD contributed to experimental implementation and data analysis, JS contributed to experimental implementation and literature search, YB, JL, XD participated in the development of the research plan, CH provided technical support, YJ supervised the entire project and made contributions at all stages, HH provided technical support and revised the manuscript.

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Lipid Profiling of Oily Skin in Chinese Female Aged 22-28 and 29-35


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국문초록

《황제내경》의 생체리듬이론으로 정의된 22-28세 및 29-35세 중국 여성의 지성 피부에 대한 지질 프로파일링

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목적: 고대 중국 의학서인 《황제내경》에 나오는 생활 리듬에 따르면 여성의 성장과 발달은 22-28세 사이에 정점에 이르며 근육과 뼈가 튼튼하고 머리카락이 풍성하고 풍관하다. 여칠남팔(女七男八) 주기에 따라 분류된 다양한 발달 단계에서 여성 지성 피부의 안면 지질 특성을 조사하고 황제내경의 노화 이론에 대한 기계적 통찰력을 제공하고자 한다.

방법: 초고성능 액체 크로마토그래프-4중극자 탄덤 비행 시간질량분석(LC-QTOF-MS)를 이용하여 두 그룹의 건강한 지성 피부(O1 그룹: 22-28세; O2 그룹: 29-35세)의 얼굴 지질 구성과 차별을 분석하였다. O1과 O2 그룹 간의 차등 지질은 직교부분최소자승판별(OPLS-DA) 모델을 사용하여 식별하였다.

결과: O1군과 O2군 사이에 피부 장벽 기능에는 유의미한 차이가 발견되지 않았다. 반면에, 피부 탄력과 피부 광채는 유의미한 변화를 보였으며, O2군에서는 피부 탄력이 감소하고 피부가 칙칙하였다. 이는 황제내경의 설명과 일치한다. 지질 프로필 분석에서 7개의 지질 클래스 중 7개의 지질 클래스의 상대 수준은 O2그룹이 O1그룹에 비해 유의하게 높았다(p<0.05). 차등 지질 중에서 미리오신, 포스파티딜세린, 플라보노이드 화합물 및 스핑가닌은 피부 탄력(R2) 및 피부 윤기(TIA)와 유의미하게 음의 상관관계를 나타냈다(p<0.05).

결론: 이상 확인된 7가지 지질종은 피부 노화 지표의 표적으로써, 피부 탄력과 얼굴빛을 유지하는 화장품 개발에 매우 중요한 의미가 있다.

핵심어: 노화, 피부표면지질, 지성피부, 황제내경, 지질체학
中文摘要

脂质组学探究基于《黄帝内经》生命节律理论划分的22-28岁与29-35岁中国女性油性皮肤本底差异

目的: 根据古代医学经典《黄帝内经》的生命节律理论，女性22至28岁之间骨骼强壮，毛发旺盛，生长发育达到顶峰。为了探讨基于“女七男八”节律划分的不同发育阶段女性油性皮肤的面部脂质特征，并为《黄帝内经》的生命节律理论提供机制见解，本文采用超高效液相色谱-四极杆飞行时间串联质谱(UPLC-QTOF-MS)技术，分析了两个健康女性油性皮肤组(O1组:22-28岁；O2组:29-35岁)的面部脂质组成，利用正交偏最小二乘判别分析(OPLS-DA)模型鉴定O1和O2组之间的差异脂质。方法: 通过UPLC-QTOF-MS技术分析两个健康女性油性皮肤组O1组与O2组的面部脂质组成。利用正交偏最小二乘判别分析(OPLS-DA)模型鉴定O1和O2组之间的差异脂质。结果: O1组和O2组之间的皮肤屏障功能无显著差异。皮肤弹性和皮肤光泽度表现出显著变化，O2组皮肤弹性降低且皮肤暗沉，这与《黄帝内经》的描述一致。在脂质谱方面，八类主要脂质中有七类脂质[FA]、[GL]、[GP]、[PK]、[PR]、[SP]和[ST]在O2组的相对水平显著高于O1组(p<0.05)。在差异脂质种类中，多球壳菌素、芥酸酰胺、磷脂酰丝氨酸、类黄酮化合物和鞘脂与皮肤弹性(R2)和皮肤光泽度(ITA)显著负相关(p<0.05)。结论: 以上七种脂质对于靶向皮肤衰老标志物探索，维持皮肤弹性和色泽的化妆品的开发具有重要意义。

关键词: 衰老，皮肤表面脂质，油性皮肤，黄帝内经，脂质组学