

# Evaluation of *Pyrus communis* and *Cydonia oblonga* fruit extract loaded emulgel on skin pliancy by using Cutometer

Tanzila Khiljee<sup>1</sup>, Naveed Akhtar<sup>1</sup> and Sonia Khiljee<sup>2</sup>

<sup>1</sup>Department of Pharmacy, The Islamia University of Bahawalpur, Bahawalpur, Pakistan.

<sup>2</sup>Shahida Islam College of Pharmacy, Lodhran, Pakistan

**Abstract:** Current study was designed to determine the skin elasticity potential of tested emulgel formulations. One emulgel containing *Pyrus communis* fruit extract and the other had *Cydonia oblonga* fruit extract. For this purpose 26 female subjects were selected and divided into two batches. Each batch has 13 volunteers, who used tested formulations and their base for 90 days. Skin elasticity were observed by using Cutometer MPA 580. From Cutometer skin mechanical parameters were calculated. From the results it was noted that emulgel formulations containing extracts of *Pyrus Communis* and *Cydonia oblonga* showed marked effect on the facial skin mechanical properties during 90 days study period. Statistically observed skin mechanical parameters of tested formulations had significant difference from base. After distention from Cutometer both formulations enhance the retraction ability of the skin as compared to base. Moreover it was also noted that *Cydonia oblonga* had more pronounced results than *Pyrus communis* loaded emulgel. From the results it has been interpreted that although both formulations has good potential to hydrate the skin resulting in intensification of its elasticity. As both fruits are rich source of phytonutrients like Vitamin C, Sugar, organic acids which might be the reason of their enhancement potential of skin pliancy.

**Keyword:** *Pyrus communis*, *Cydonia oblonga*, emulgel, cutometer, skin pliancy.

## INTRODUCTION

Skin is the largest part of the body. In humans skin is effected by aging and environmental effects. So if damage due to aging and environmental factors penetrates deeper upto dermis then it will affect the skin elasticity. Skin dermis has collagen and elastin fibers. Elastin keep skin elastic and collagen maintain skin integrity, so as a whole both collagen and elastin managed the skin flexibility. Loss of skin pliancy is known as elastosis. In this condition the skin become sagged and wrinkled. Skin elasticity has been decreased by many external and internal agents. External agents include sunrays, humidity and air contamination. Internal agents are poor nutrition and aging. Relationship of aging with skin elasticity is direct. As the age increases skin elasticity go on decreasing. Increase in age affect the skin mechanical properties (Flament *et al.*, 2021; Ahn *et al.*, 2007).

Skin elasticity can be improved internally by using more water and balanced diet. Fruits are rich source of nutrients which help in the restoration of elasticity by increasing collagen and elastin fibers. *Rosaceae* family fruits particularly *Pyrus communis* and *Cydonia oblonga* contains many phytonutrients which help in enhancement of skin elasticity. *Pyrus communis* fruit is rich source of fibers, vitamin C, Antioxidants and arbutin (Hughes *et al.*, 2022; Kaur and Arya, 2012). It is widely used by common ladies as a cleanser for enhancing skin tonicity. Moreover *Cydonia oblonga* contains sugars, organic acids, tannins,

flavonoid and phenolic contents (Silva *et al.*, 2002). Common ladies used *Cydonia oblonga* fruit as healing agent. Moreover also used as moisturizer. Its herbal mixture used to decrease wrinkles and make skin tight (Echard and Droux, 2014).

In laboratory skin elasticity can be measured by Cutometer. It is an instrument used for assessment of skin mechanical properties. It is a non-invasive instrument which works by suction pressure and determine skin firmness behavior. Cutometer is used in research laboratories normally for assessing the potential of new antiaging cosmetic formulations. Good antiaging topical formulation helps in intensification of skin hydration and elasticity (Charnvanich *et al.*, 2018). Cutometer measures the skin firmness by measuring its potential to resume its original condition. Results are exhibited in curves. Observed R Parameters measured mathematically and statistically in order to describe the cosmetic formulation skin elasticity potential (Myoung *et al.*, 2021; Rodrigues and Fluhr, 2020).

Purpose of the current study was the assessment of two emulgel formulations loaded with fruit extracts of *Pyrus communis* and *Cydonia oblonga* on elasticity of facial skin of female volunteers by using Cutometer MPA 580. Both formulations were compared with their respective bases. 26 female subjects were enrolled in this study and skin mechanical R parameters (R0, R2, R5, R7 & R8) were noted by using Cutometer MPA580.

\*Corresponding author: e-mail: tk\_pharmacist786@yahoo.com

## MATERIALS AND METHODS

### Reagents & Chemicals

Liquid paraffin, propylene glycol and triethanolamine (Merck, Germany). Methyl parabin (Acros, USA. Span 20, Carbopol 940 and tween 20 (Sigma, USA). All substances used were of analytical grade.

### Instruments

Cutometer MPA 580, MPA 5 (Germany), Rotary evaporator (Japan), Homogenizer (Germany), pH-Meter (Germany), Electric balance (Switzerland) and water bath (China).

### Botanical material & extracts

The *Pyrus communis* fresh fruit were obtained from Azad Kashmir and *Cydonia oblonga* fruit obtained from Islamabad Pakistan. Recognition of the fruits was done by the Department of Plant Sciences, Herbarium of Quaid-e-Azam University, Islamabad, Pakistan. Samples were allocated certificate number of (C# 805) and (C# 1125) respectively for *Pyrus communis* and *Cydonia oblonga*. Methanolic Fruit extracts of both fruits named *Pyrus communis* and *Cydonia oblonga* were prepared in the Islamia University Laboratory.

### Preparation of cosmetic emulgel

Emulgel was formulated by adding watery phase to oily phase by constant stirring to produce an oil-in-water emulsion. The O/W emulsion was incorporated to gel under constant shaking for 10-20 min by using a digital high shear mixer. In order to obtain a good odor few drops of fruit oil was added in emulgel as it enhance its appeal for female participants.

All tested formulations (emulgel O/W formulation and base) were found to qualify in vitro evaluation tests like pH, electrical conductivity, centrifugation, phase separation. Moreover temperature stability tests were also done at  $8\pm 0.1^{\circ}\text{C}$ ,  $25\pm 0.1^{\circ}\text{C}$ ,  $40\pm 0.1^{\circ}\text{C}$  and  $40\pm 0.1^{\circ}\text{C}$  with 75% RH (in incubator) and physical properties i.e., color, liquefaction and creaming. All formulated emulgel and base were stable.

### Participants enrollment and study protocol

#### Ethical Approval

The current research was sanctioned by the Board of Advanced Study and Research (BASAR), and institutional ethical committee, Faculty of Pharmacy & Alternative Medicine, The Islamia University of Bahawalpur, This current work was permitted by the PREC for *in vivo* studies (Ref. No. 46/S-2018-/PREC), The Islamia University of Bahawalpur, Pakistan and directed according to the worldwide (International) guiding principle of Helsinki Declaration. Before the study, every subject signed subject protocol. This protocol was a bilingual consent form which had all the terms and conditions like aim of the study, duration of study, danger

associated with study and future prospects of the study. Subjects were not acquainted about the formulations.

### Inclusive criteria for participants

- The age of participant must be healthy and was within the range of ages at 22-30 years.
- No subject should have any record of hypersensitivity on the skin (especially of cheeks /forearms).
- No subject should apply any other extra cosmetological product/cream on the skin of face (at least 2 weeks before study and throughout the whole study period of 12 weeks).
- Every subject should educate properly and sign the participants agreement for written literate consent.
- At specific time periods participants should come to laboratory in time for the measurements of parameters for 03 months.
- Before observations of all indicators, participants should wait for at least 30 minutes in order to allow for complete skin adjustment to the lab environment at  $25^{\circ}\text{C}$  (room temperature).

### Exclusive criteria for participants

- Any participants under treatment for skin diseases in entire study period.
- Any participants should have any hypersensitivity to any constituent of the formulation or with any record of sensitivity.
- Any subject who have going to steroidal therapy.
- Any subject should not follow the formulation guidelines of the cosmetological formulations. Any subject who have excessive hair growth on the cheeks.

It was a single blind study for the determination of skin flexibility potential of two emulgel i.e. the active emulgel containing fruit extracts and base emulgel without extract. In this study two fruit extracts named *Pyrus communis* and *Cydonia oblonga* fruit extracts loaded emulgel were compared with their base. 26 healthy female participants were choosed and splited into two groups. One group was provided with *Pyrus communis* loaded emulgel and base. Other group was provided with *Cydonia oblonga* loaded emulgel and base. Participants were instructed about the application of formulations (active formulation and base) on the cheeks (right and left) two times a day. Every participant provided with a schedule of 2<sup>nd</sup> week, 4<sup>th</sup>, 8<sup>th</sup>, 10<sup>th</sup> and 12<sup>th</sup> week of research period (Huma *et al.*, 2022; Khiljee and Akhtar, 2019).

### Burchard test (Patch test)

In order to determine skin irritation potential Burchard test was performed for all tested formulations. In this test, a patch was applied on the 5x4 cm marked area of forearm. On right arm the base was applied and on the left forearm tested formulation loaded with fruit extract was applied and measured the skin erythema potential. After 48 hours, skin redness was measured from Mexameter.

No formulation cause irritation so all qualified the patch test (Ijaz *et al.*, 2019).

### Cutometer Skin measurements

Cutometer (Cutometer MPA 580) is a non-invasive instrument used for the skin elasticity and biomechanical parameters of the skin. Facial skin was sucked by a metering probe 2mm by continuous application of negative suction pressure (350 mbar) for 18 seconds and then pressure was switch off and skin returns to its original condition. Moreover it has optical measuring system which contains light source and receptor, also two prisms confronting each other. It projects light from transmitter to receptor. As skin penetration depth varies so light intensity also varies. Cutometer produced a graph which is used for assessing skin mechanical (R) parameters. Graph normally measures following parameters, Ue: Skin extensibility, Uv: Delayed distension, Uf: Final deformation, Ur: Immediate retraction, Ua: Total recovery, R: Residual deformation at the end of measuring cycle R. Observed graphs obtained from Cutometer were interpreted both statistically & mathematically (Rodrigues and Fluhr, 2020; Charnvanich *et al.*, 2018).

The percentage changes observed weekly after application of tested formulation for the individual values of different factors of subjects were calculated by the following formula:

$$\text{Percentage change} = [(A - B) / B] * 100$$

Where A = individual value of any factor of 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup> week and 12<sup>th</sup> week

B = zero hour value of that factor (Akhtar *et al.*, 2010).

### Measured R parameters

R parameters calculated from Cutometer denotes the skin elasticity (Ohshima *et al* 2013). In the present study the parameters noted were R0, R2, R5, R7 & R8. Observed R Parameters denotes following skin biomechanical properties.

R0=it is total skin dispensability,

R2= Ua/Uf Biological elasticity,

R5= Ur/Ue Elastic Function,

R7= Ur/Uf Firmness/elastic recovery,

R8= Ua Total reposition of the initial curve (Rodrigues and Fluhr, 2020).

### STATISTICAL ANALYSIS

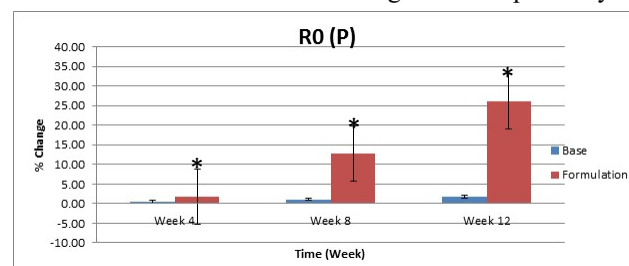
Results obtained after evaluating different parameters R0, R2, R5, R6, R7 and R8 were interpreted using (SPSS, V. 17.0). Paired sample test T-test (PSTT) used for determination of variation between two formulations (active formulation and base). Two-way ANOVA was used for variation between different time intervals and post-hoc analysis through LSD (least Significant Difference). Which is used for computing "pairwise

comparisons", i.e. the smallest significant difference between two means variation. Difference is considered to be significant if P value is less than 5% (P<0.05) (Khiljee and Akhtar, 2019).

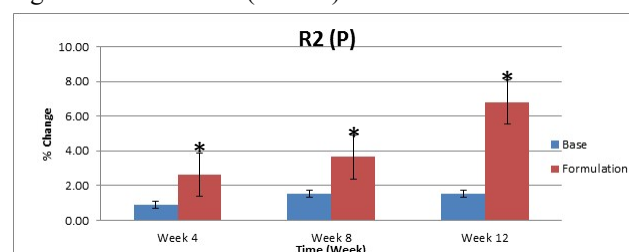
### RESULTS

#### Skin elasticity parameters of *Pyrus communis* containing cosmetic emulgel

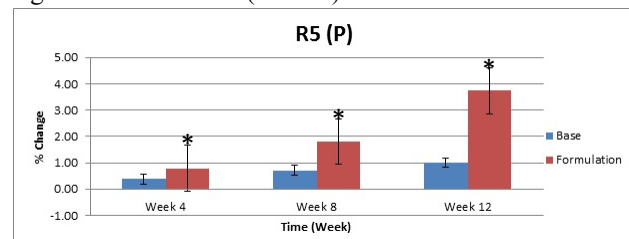
After application of emulgel containing *Pyrus communis* on the facial skin of female subjects for 12 weeks. R-parameters of active formulation loaded with fruit extract of *Pyrus communis* named as F1 formulation and base emulgel were noted. Results of elasticity values were observed in triplicates (n =3). The percent change in the R-parameter named R0, R2, R5, R7 & R8 as a function of time for active emulgel formulation (F1) containing *Pyrus communis* versus base showed in fig. 1 to 5 respectively.



**Fig. 1:** Elasticity considerations of R0 parameter of active formulation F1 versus base. \*indicates statistically significant difference (P<0.05)



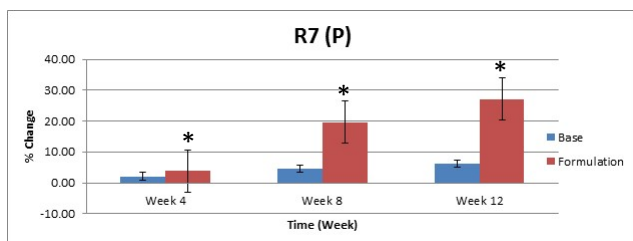
**Fig. 2:** Elasticity considerations of R2 parameter of active formulation F1 versus base. \*indicates statistically significant difference (P<0.05)



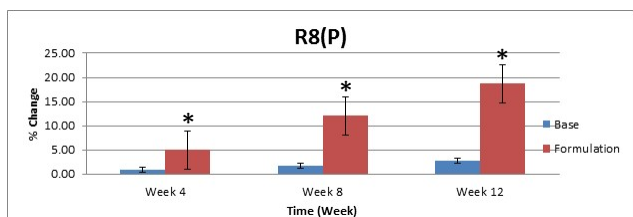
**Fig. 3:** Elasticity considerations of R5 parameter of active formulation F1 versus base. \*indicates statistically significant difference (P<0.05)

Formulation (F1) Results exhibited a significant increase (p<0.05) as compared to base. The readings of R0 near to 01 % after 4<sup>th</sup> week, after 8<sup>th</sup> week reading is equal to 13 % and after 12<sup>th</sup> week reading is greater than 25%. The

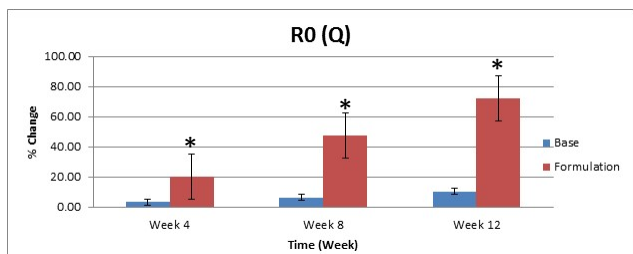
R2 parameter showed reading greater than 2.5 % within 4<sup>th</sup> week, after 8<sup>th</sup> week reading is greater than 3.5% and after 12<sup>th</sup> week reading is greater than 6.5%. The reading of R5 parameter is greater than 0.75% within 4<sup>th</sup> week, after 8<sup>th</sup> week reading is greater than 1.5% and after 12<sup>th</sup> week reading is greater than 3.5%. The reading of R7 parameter in 4<sup>th</sup> week is greater than 3.5%, after 8<sup>th</sup> week reading is greater than 19% and after 12<sup>th</sup> week reading is greater than 26%. The R8 factor show reading equal to 5% after 4<sup>th</sup> week, after 8<sup>th</sup> week reading is greater 12% and after 12<sup>th</sup> week reading is greater than 17% in the whole study period of three months. By applying the statistical analysis of two-way ANOVA test and PSTT (Paired sample t-test) the results of active formulation F1 showed significant increase in percentage change of R parameters in the whole study time period of three month as compared to base.



**Fig. 4:** Elasticity considerations of R7 parameter of active formulation F1 and base. \*indicates statistically significant difference (P<0.05)



**Fig. 5:** Elasticity considerations of R8 parameter of active formulation F1 versus base. \*indicates statistically significant difference (P<0.05)

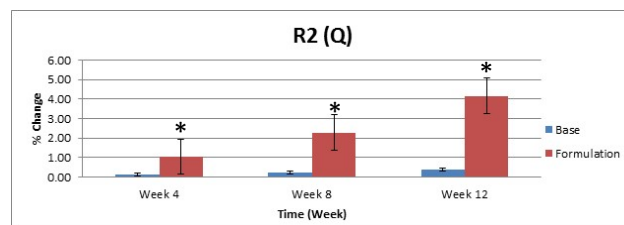


**Fig. 6:** Elasticity considerations of R0 parameter of active formulation F2 versus base. \*indicates statistically significant difference (P<0.05)

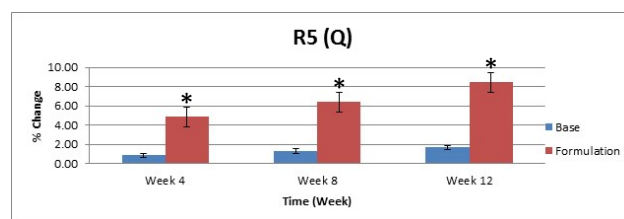
**Skin elasticity Parameters of *Cydonia oblonga* containing cosmetic emulgel**

After application of emulgel formulation containing *Cydonia oblonga* on the facial skin of female subjects. R-

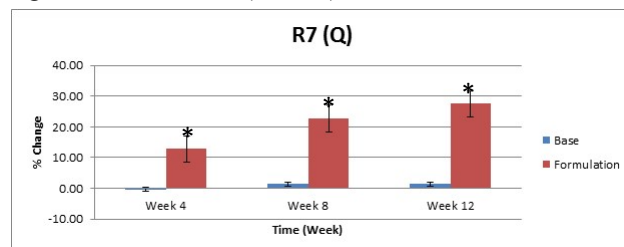
parameters of active formulation loaded with fruit extract of *Cydonia oblonga* named as F2 formulation and base emulgel were noted. Results of elasticity values were observed in triplicates (n=3). The percent change in the R-parameter R0, R2, R5, R7 and R8 as a function of time for active formulation (F2) containing *Cydonia oblonga* versus base showed in fig. 6 to 10 respectively.



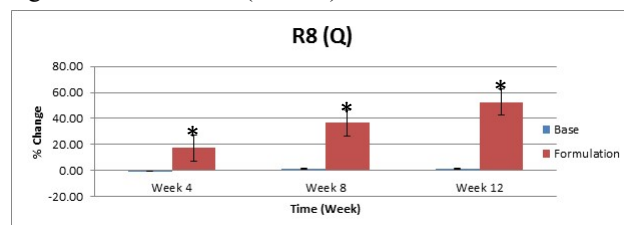
**Fig. 7:** Elasticity considerations of R2 parameter of active formulation F2 versus base. \*indicates statistically significant difference (P<0.05)



**Fig. 8:** Elasticity considerations of R5 parameter of active formulation F2 versus base. \*indicates statistically significant difference (P<0.05)



**Fig. 9:** Elasticity considerations of R7 parameter of active formulation F2 versus base. \*indicates statistically significant difference (P<0.05)



**Fig. 10:** Elasticity considerations of R8 parameter of active formulation F2 versus base. \*indicates statistically significant difference (P<0.05)

Formulation (F2) results exhibited a significant increase (p<0.05) in the reading of R0 equal to 20% in 4<sup>th</sup> week then after 8<sup>th</sup> week value was greater than 38% and after 12<sup>th</sup> week value was greater than 70%, R2 parameter showed reading equal to 01% in 4<sup>th</sup> week, after 8<sup>th</sup> week

value was greater than 2% and after 12<sup>th</sup> week value was greater than 4%, the reading of R5 parameter at 4<sup>th</sup> week was greater than 4%, after 8<sup>th</sup> week reading was greater than 6% and after 8<sup>th</sup> week value was greater than 8%, the reading of R7 parameter at 4<sup>th</sup> week was greater than 11%, after 8<sup>th</sup> week value was greater than 20 % and after 12<sup>th</sup> week value was greater than 26%. R8 factor show reading greater than 15% after 4<sup>th</sup> week, after 8<sup>th</sup> week reading was greater than 35% and after 12<sup>th</sup> week value was greater than 50% in the whole study period of three months. By applying the statistical analysis of two-way ANOVA test and PSTT (Paired sample t-test) the results of active formulation F2 showed significant increase in percentage change of R parameters in the whole study time period of three month as compared to base.

## DISCUSSION

The most important function of skin contributes the feeling of physical attractiveness and wellbeing that decreases with passage of time which has properties of coarsening of elastosis, collagen, laxity, wrinkle development, atrophy, decrease water contents and imbalance pigmentation. Skin elasticity can be enhances externally by using different antiaging cosmetics (Myoung *et al.*, 2021; Langton *et al.*, 2019).

Overall both tested formulations F1 & F2 containing *Pyrus communis* and *Cydonia oblonga* extracts showed good values of R parameters. This attitude is consistent with the previous studies in which values of R parameters near to 1 are indicator of skin elasticity (Cho *et al.*, 2009; Wissing and Müller, 2003; Akhtar *et al.*, 2010).

In current study formulations named F1 and F2 containing fresh fruit extract of *Pyrus communis* and *Cydonia oblonga* showed high values of R0 parameter after 12 week study time period. R0 denotes highest point of curve which shows maximum skin expandability. It also represent skin firmness behavior against applied pressure. In case of *Pyrus communis* Vitamin C and tannins might be responsible for this parameter (Kaur and Arya, 2012). In *Cydonia oblonga* chlorogenic acids like caffeoylquinic acid and dicaffeoylquinic acid and Vitamin C help in the collagen fiber formation so it help in the skin elasticity and hydration (Silva *et al.*, 2002). As both fruits owing abundant amount of antioxidant and vitamin C which aid in the restoration of collagen fiber which is the main protein in the skin connective tissue responsible for maintaining skin elasticity (Rittié and Fisher, 2002; Uitto, 1986). Topical formulations containing Vitamin C has been used to enhance the production of elastin and collagen. Furthermore also protect skin from oxidizing effect of sunrays (Humbert *et al.*, 2003). Among both emulgel formulations results *Cydonia oblonga* loaded emulgel showed increase Ro then *Pyrus communis* loaded emulgel. It showed enhanced skin mechanical potential.

Both tested emulgel formulations demonstrated a significant increase in the R2 as compared to base. The same effect was also reported in a previous work (Sungyeon *et al.*, 2007). R2 and R7 are main factors used for assessing antiaging effect of cosmetics (Charnvanich *et al.*, 2018; Kim *et al.*, 2019; Ahn *et al.*, 2007).

R5 parameters of both emulgels prepared from fruit extracts showed good results. It might be due to presence of antioxidant and many polyphenols present in them (Dreher *et al.*, 2001). This effect is also evident from previous literature in which plant having including resveratrol, anthocyanidin and ellagic acids showed significant influence on the skin elasticity. Another work stated that antioxidant had marked effect on skin flexibility (Manosroi *et al.*, 2011). In another study this hypothesis was supported in that work emulsion containing extract had marked antioxidant potential as indicated by the ingredients like, rutin, vitamin C and quercetin and it also enhance the skin elasticity (Modh *et al.*, 2011).

R7 (Hong *et al.*, 2002) values showed an increment in skin elasticity potential of both tested formulations as compared to base formulation. As also evident in previous studies where O/W emulsion containing extract of *Hippophae rhamnoides* showed increase in skin mechanical properties as observed by Cutometer (Khan *et al.*, 2012). Sunrays are source of Ultraviolet radiations which produce such enzymes in skin which cause damage to skin elastin fibers. Antiaging formulations help in the decreasing aging caused by external factors like UVB radiation by protecting the elastic fiber network of the skin causing increment in the skin elasticity. (Tsukahara *et al.*, 2001).

R8 denotes the skin ability to restore its original condition (Rodrigues and Fluhr, 2020). Emulgel having *Cydonia oblonga* showed more pronounced effect on skin mechanical properties as compared to emulgel containing *Pyrus communis*. R8 is actually the parameter which is related to viscoelastic parameter of skin. Skin has a natural viscoelastic behavior (Small *et al.*, 2006). This behavior is modified by moisturizers. This observed parameter is consistent with the previous studies in which topical cosmetics has effect on skin viscoelasticity (Akhtar *et al.*, 2010).

## CONCLUSION

In the present study emulgel formulations containing *Pyrus communis* and *Cydonia oblonga* showed marked effect on facial skin of female subjects as compared to base. It was found that the both formulations had the ability to enhance skin elasticity. Another parameter observed was that although both formulations showed good results but *Cydonia oblonga* loaded emulgel formulations had better results as compared to *Pyrus*

*communis*. There is no other study reported yet representing skin elasticity determinations using *Pyrus communis* loaded emulgel and *Cydonia oblonga* loaded emulgel. Both formulations proved to be good addition in the antiaging cosmetics.

## REFERENCES

- Aburjai T and Natsheh FM (2003). Plants used in cosmetics. *Phytother. Res.*, **17**(9): 987-1000.
- Ahmad HI, Khan MS and Akhtar N (2020). Development of topical drug delivery system with *Sphaeranthus indicus* flower extract and its investigation on skin as a cosmeceutical product. *J. Cosmet. Dermatol.*, **19**(4): 985-994.
- Ahmad HI, Khan MS, Akhtar N and Ijaz S (2021). Phenolic, flavonoid content and radical scavenging activity of *Smilax china* with its inhibitory potential against clinically important enzymes. *Nat. Prod. Res.*, **35**(12): 2066-2071.
- Ahn S, Kim S, Lee H., Moon S and Chang I (2007). Correlation between a cutometer and quantitative evaluation using Moire topography in age-related skin elasticity. *Skin. Res. Technol.*, **13**(3): 280-284.
- Akhtar N, Waqas MK, Ahmad M, Saeed T, Murtaza G, Rasool A, Aamir MN, Khan SA, Bhatti NS and Ali A (2010). Effect of cream formulations of fenugreek seed extract on some mechanical parameters of human skin. *Trop. J. Pharm. Res.*, **9**(4): 329-337.
- Akhtar N, Zaman SU, Khan BA, Aamir MA and Ebrahimzadeh MA (2011). Calendula extract: Effect on mechanical parameters of human skin. *Acta. Pol. Pharm.*, **68**(5): 639-701.
- Arshad W, Khan MS, Akhtar N and Mohammad IS (2020). Polymeric emulgel carrying *Cinnamomum tamala* extract: promising delivery system for potential topical applications: Promising delivery system for potential topical application. *Braz. J. Pharm. Sci.*, **56**(e18318): 1-11.
- Belo DS, Gaspar LR and Campos MP (2006). Moisturizing effect of cosmetic formulations containing Aloe vera extract in different concentrations assessed by skin bioengineering techniques. *Skin. Res. Technol.*, **12**(4): 241-246.
- Charnvanich D, Panapisal V, Suwakul W and Tansirikongkol A (2018). Effects of age, hydration level, and cosmetic treatment on skin mechanical properties of Thai. *Thai. J. Pharm. Sci.*, **42**(3): 146-151.
- Cho S, Lee S, Lee M.J, Lee DH, Won CH, Kim SM And Chung JH (2009). Dietary Aloe vera supplementation improves facial wrinkles and elasticity and it increases the type I procollagen gene expression in human skin in vivo. *Ann. Dermatol.*, **21**(1): 6-11.
- Dobrev H (2000). Use of Cutometer to assess epidermal hydration. *Skin Res. Technol.*, **6**(4): 239-244.
- Dobrev H (2005). Application of cutometer area parameters for the study of human skin fatigue. *Skin Research and Technology.*, **11**(2): 120-122.
- Dobrev H (2007). Clinical and instrumental study of the efficacy of a new sebum control cream. *J. Cosmet. Dermatol.*, **6**(2): 113-118.
- Dobrev H (2002). A study of human skin mechanical properties by means of Cutometer. *Folia Med (Plovdiv).*, **44**(3): 5-10.
- Dreher F and Maibach H (2001). Protective effects of topical antioxidant in humans. oxidants and antioxidants in cutaneous biology. *Curr. Probl. Dermatol. Basel. Karger.*, **29**: 157-164.
- Echard A and Droux J (2014). *Cydonia oblonga* (Quince) leaf extract A new solution for sensitive skin. *Skin Care.*, **9**(2): 10-12.
- Flament, F, Prunel A, , Keufer B, Abric A, Wang Y, Reni A, Cassier M and Caroline Delaunay (2021). Changes in facial signs due to age and their respective weights on the perception of age and skin plumpness among differently aged Korean women. *Skin Res. Technol.*, **27**(4): 526-536.
- Hong SY, Sei HB and Chil HO (2002). Quantitative measurements of desquamation and skin elasticity in diabetic patients. *Skin. Res. Technol.*, **8**(4): 250-254.
- Hughes S, Kolsters N, Klashorst DV, Kreuter E and Buter KB (2022). An extract of *Rosaceae*, *Solanaceae* and *Zingiberaceae* increases health span and mobility in *Caenorhabditis elegans*. *BMC. Nutr.*, **8**(5): 1-12.
- Huma S, Shoaib MK, Ijaz S, Sarfaraz M, Zaka SH and Ahmad A (2022). Development of niacinamide/ferulic acid-loaded multiple emulsion and its *in vitro/in vivo* investigation as a cosmeceutical product. *Biomed. Res. Int.* **2022**: Article ID 1725053, 13 Pages.
- Huma S, Khan MS and Sohail M (2020). Development, *in vitro* characterization and assessment of cosmetic potential of *Beta vulgaris* extract emulsion. *J. Herb. Med.*, **23**: 100372.
- Humbert PG, Haftek M, Creidi P, Lapière C, Nulgens B, Richard A, Schmitt D, Rougier A and Zahouani H (2003). Topical ascorbic acid on photoaged skin. Clinical, topographical and ultrastructural evaluation: Double - blind study vs. placebo. *Exp. Dermatol.*, **12**(3): 237-244.
- Ijaz S, H. Khan MS, Anwar Z, Talbot B and Walsh JJ (2019). HPLC profiling of *Mimosa pudica* polyphenols and their non-invasive biophysical investigations for anti-dermatoheliotic and skin reinstating potential, *Biomed. Pharmacother.*, **109**: 865-875.
- Jachowicz J, McMullen R and Prettypaul D (2008). Alteration of skin mechanics by thin polymer films. *Skin. Res. Technol.*, **14**(3): 312-319.
- Kaur R and Arya V (2012). Ethanomedicinal and phytochemical perspectives of *Pyrus communis* (L). *J. Pharmacogn. Phytochem.*, **1**(2): 14-19.
- Khan BA, Akhtar N and Braga VA (2012). Anti-aging effects of *Hippophae rhamnoides* emulsion on human skin. *Trop. J. Pharm. Res.*, **12**(6): 955-962.

- Khiljee T and Akhtar N (2019). Investigation of antiaging and skin rejuvenation potential of phytoconstituents from *Pyrus communis* loaded topical emulgel. *Pak. J. Pharma. Sci.*, **32**(1): 293-300.
- Kim SH, Lee SJ, Kim HJ, Lee JH, Jeong HS and Suh IS (2019). Aging-related changes in the mid-face skin elasticity in East Asian women. *Arch. Craniofac. Surg.*, **20**(3): 158-163.
- Koch RJ and Cheng ET (1999). Quantification of skin elasticity changes associated with pulsed carbon dioxide laser skin resurfacing. *Arch. Facial. Plast. Surg.*, **1**(4): 272-275.
- Langton AK, Graham HK, Griffiths CE, Watson RE (2019). Ageing significantly impacts the biomechanical function and structural composition of skin. *Exp. Dermatol.*, **28**(8): 981- 984.
- Lee J, Lee S, Kim SL, Choi JW, Seo JY, Choi DJ and Park YI (2014). Corn silk maysin induces apoptotic cell death in PC-3 prostate cancer cells via mitochondria-dependent pathway. *Life. Sci.*, **119**(1-2): 47-55.
- Lynch B, Pigeon H, Blay HL, Brizion S, Bastien P, Bornschoegl T and Domanov Y (2022). A mechanistic view on the aging human skin through ex vivo layer-by-layer analysis of mechanics and microstructure of facial and mammary dermis. *Sci. Rep.*, **12**(1): 849: 14 Pages.
- Maksimovic Z, Malencic D and Kovacevic N (2005). Polyphenol contents and antioxidant activity of *Maydis stigma* extracts. *Bioresour. Technol.*, **96**(8): 873-877.
- Manosroi A, Jantrawut P, Akihisa T, Manosroi W and Manosroi J (2011). *In vitro* and *in vivo* skin anti-aging evaluation of gel containing niosomes loaded with a semi-purified fraction containing gallic acid from *Terminalia chebula* galls. *Pharm. Biol.*, **49**(11): 1190-1203.
- Modh KM, Parmar PT, Panigrahi B, Anand IS and Patel CN (2011). Pharmacognostical and phytochemical evaluation of leaves of *Bauhinia variegata* Linn. *Phcog. J.*, **3**(24): 45-49.
- Myoung J, Jeog ET, Kim M, Lim JM, Kang NG and Park SG (2021). Validation of the elastic angle for quantitative and visible evaluation of skin elasticity *in vivo*. *Skin. Res. Technol.*, **27**(6): 1017-1022.
- Nayla J, Ijaz S, Akhtar N and Khan MS (2022). Nanostructured ethosomal gel loaded with *Arctostaphylos uva-ursi* extract; *In vitro/in-vivo* evaluation as a cosmeceutical product for skin rejuvenation. *Curr. Drug. Deliv.*, **19**(6): 706-720.
- Ni X, Guo Q, Zou Y, Xuan Y, Mohammad IS, Ding Q and Hu H (2020). Preparation and characterization of bear bile-loaded pH sensitive in-situ gel eye drops for ocular drug delivery. *Iran. J. Basic. Med. Sci.*, **23**(7): 922-929.
- Ohshima H, Kinoshita S, Oyobikawa H, Takiwaki H, Ishiko A and Kanto H (2013). Use of cutometer area parameters in evaluating age related changes in the skin elasticity of the cheek. *Skin. Res. Technol.*, **19**(1): 238-242.
- Paye M, Mac-Mary S, Elkhyat A, Tarrit C, Mermet P and Humbert PH (2007). Use of the Reviscometer for measuring cosmetics-induced skin surface effects. *Skin. Res. Technol.*, **13**(4): 343-349.
- Rittié L and Fisher GJ (2002). UV-light-induced signal cascades and skin aging. *Ageing. Res. Rev.*, **1**(4): 705-720.
- Rodrigues ML and Fluhr JW (2020). EEMCO Guidance for the *in vivo* assessment of biomechanical properties of the human skin and its annexes: Revisiting instrumentation and test modes. *Skin, Pharmacol. Physiol.*, **33**(1): 44-59.
- Saleem A, Jamil QA, Khan MS and Ijaz S (2022). Development, characterization and clinical investigation of *Spinacia oleracea*-based ultra-high pressure homogenized emulsion system for facial physiological parameters. *J. Cosmet. Dermatol.*, **21**: 1-13.
- Segger D and Schönlau F (2004). Supplementation with Evelle® improves skin smoothness and elasticity in a double - blind, placebo - controlled study with 62 women. *J. Dermatolog. Treat.* **15**(4): 222-226.
- Sharadha M, Gowda D, Gupta V and Akhila AR (2020). An overview on topical drug delivery system - updated review. *Int. J. Pharm. Sci. Res.*, **11**(1): 368-385.
- Silva BM, Andrade PB and Mendes GC (2002). Study of the organic acids composition of quince (*Cydonia oblonga* Miller) fruit and jam. *J. Agric. Food. Chem.*, **50**(8): 2313-2317.
- Smalls LK, Wickett RR and Visscher MO (2006). Effect of dermal thickness, tissue composition and body site on skin biomechanical properties. *Skin. Res. Technol.*, **12**(1): 43-49.
- Sungyeon A, Seunghun K, Haekwang L, Seogjoon M and Ihseop C (2007). Correlation between a cutometer and quantitative evaluation using Moire topography in age-related skin elasticity. *Skin. Res. Technol.*, **13**(3): 280-284.
- Tran D, Townley JP, Barnes TM and Greive KA (2015). An antiaging skin care system containing alpha hydroxy acids and vitamins improves the biomechanical parameters of facial skin. *Clin. Cosmet. Investig. Dermatol.*, **8**(9-17): 19 Pages.
- Tsukahara K, Takema Y, Moriwaki S, Tsuji N, Suzuki Y, Fujimura T and Imokawa G (2001). Selective inhibition of skin fibroblast elastase elicits a concentration-dependent prevention of ultraviolet B-induced wrinkle formation. *J. Invest. Dermatol.*, **117**(3): 671-677.
- Uitto J (1986). Connective tissue biochemistry of the aging dermis. Age-related alterations in collagen and elastin. *Dermatol. Clin.*, **4**(3): 433-446.
- Wissing SA and Muller RH (2003). The influence of solid lipid nanoparticles on skin hydration and viscoelasticity *in vivo* study. *Eur. J. Pharm. Biopharm.*, **56**(1): 67-72.