PERSONAL CARE

DuraQuench™ IQ

Discover an innovative approach to effective moisturisation through Croda's moisturising complex, DuraQuench IQ. Its dual mechanism optimises skin moisturisation by the formation of an intelligent structural layer on the surface of the skin, whilst regulating water loss from within by reinforcing the skin's natural barrier.

Product name	INCI name	Appearance
DuraQuench IQ	Cetyl Alcohol (and) Isostearyl Isostearate (and) Potassium Cetyl Phosphate (and) Cetyl Behenate (and) Behenic Acid	White solid

Features / Benefits

- Delivers superior moisturisation via dual action technology
- Temperature and humidity responsive
- Long lasting hydration
- Improves inherent skin barrier function
- Protects against the drying effects of soaps and detergents
- Visible improvement in skin dryness
- Smoother, more radiant skin

Applications

- Facial cream
- Eye cream
- Anti-ageing
- Moisturising/nourishing creams and lotions

Seasonal variation and temperature controlled environments can lead to skin dryness[1]. DuraQuench IQ has been developed to combat these changes in temperature and humidity, specifically by reducing water loss more effectively at low relative humidity. With effective moisturisation contributing towards anti-ageing performance[2], DuraQuench IQ delivers a significant improvement in skin barrier function for lasting hydration benefits. These benefits have led to consumer perceived improvements in skin smoothness and radiance.

Hydration Performance

DuraQuench IQ is able to significantly improve the visual signs of skin dryness as demonstrated in the following Moisture Efficacy Test (MET). The study consisted of a 7 day dry-down phase where all panellists washed their lower legs with soap and stopped the use of all moisturising products. Following this the panellists entered a 2 week treatment phase where they continued to wash their lower legs daily. During the treatment phase a DuraQuench IQ and control formulation (Table 1) were applied twice daily to randomised treatment sites along with one site which was left untreated as a negative control. The level of skin dryness was assessed throughout the treatment phase and all measurements were taken after the morning wash and before the application of the moisturising creams.

Glycerin is a commonly used moisturising ingredient and for this reason 5% glycerine was included in both the control and DuraQuench IQ formulations. This ensures that the formulations are market relevant and also provide the opportunity to demonstrate the moisturising benefits of DuraQuench IQ over and above the control.

	Control	DuraQuench IQ
	% w/w	
DuraQuench IQ (Cetyl Alcohol (and) Isostearyl Isostearate (and) Potassium Cetyl Phosphate (and) Cetyl Behenate (and) Behenic Acid (proposed))	-	5.0
Paraffinium Liquidum	5.0	-
Cithrol GMS 40 (Glyceryl Stearate)	1.2	1.2
Brij CS20 (Ceteareth-20)	0.4	0.4
Arlamol HD (Isohexadecane)	5.0	5.0
Arlamol PS15E (PPG-15 Stearyl Ether)	4.0	4.0
Dimethicone	1.0	1.0
Propylparaben	0.05	0.05
Water (Aqua)	68.2	68.2
Methylparaben	0.15	0.15
Pricerine 9091 (Glycerin)	5.0	5.0
OptaSense G82 (2% Sol.) (Acrylates/C10-30 Alkyl-Acrylate Crosspolymer)	10.0	10.0
Potassium Hydroxide	q.s.	q.s.

Table 1: Formulation with and without 5% DuraQuench IQ. Note that both formulations contain 5% glycerine. These formulations are used in all studies except the final consumer sensory perception study.

Skin dryness was assessed using a visual grading scale from 0 - 5, as seen in Figure 1 below, where 0 represents no evidence of dryness and 5 represents extremely dry skin. Due to the severity of level 5, there are no images of this level of dryness and no panellists were graded as level 5 throughout the study.

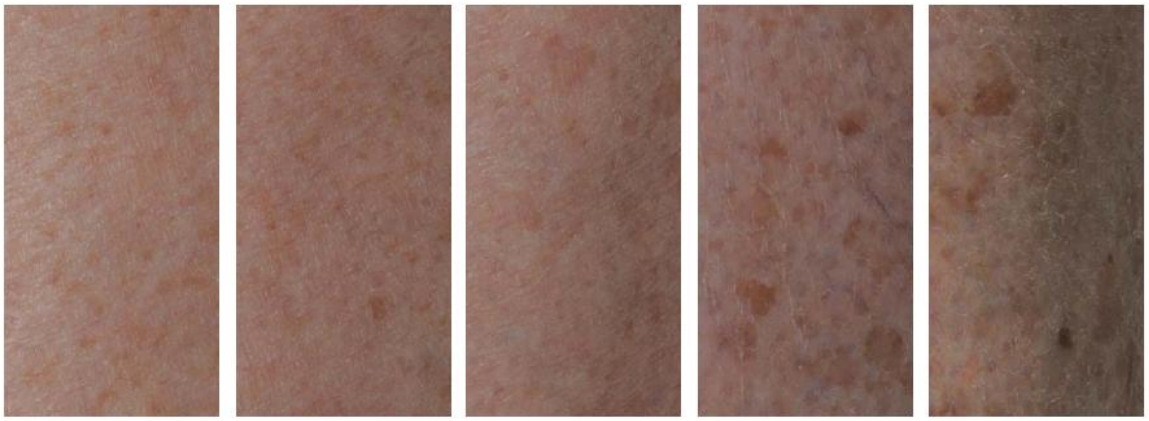


Figure 1: Dry skin of increasing severity from 0-4 on a clinical expert scale.

The results of the study show that the inclusion of DuraQuench IQ in the formulation led to greater improvements in the visible signs of skin dryness versus the control formulation, with statistically significant results on day 11 ($p<0.05$) and day 14 ($p<0.05$) of the study, as seen in Figure 2.

Following the treatment phase, panellists entered the regression phase where they **continued to wash their lower legs with soap and stopped applying the test formulations**. The level of skin dryness of all test sites was assessed following the morning wash throughout the regression phase. The skin treated with the DuraQuench IQ formulation remained significantly more moisturised than the skin treated with the control formulation on day 1 ($p<0.001$), day 2 ($p<0.01$) and day 3 ($p<0.05$) of the regression phase.

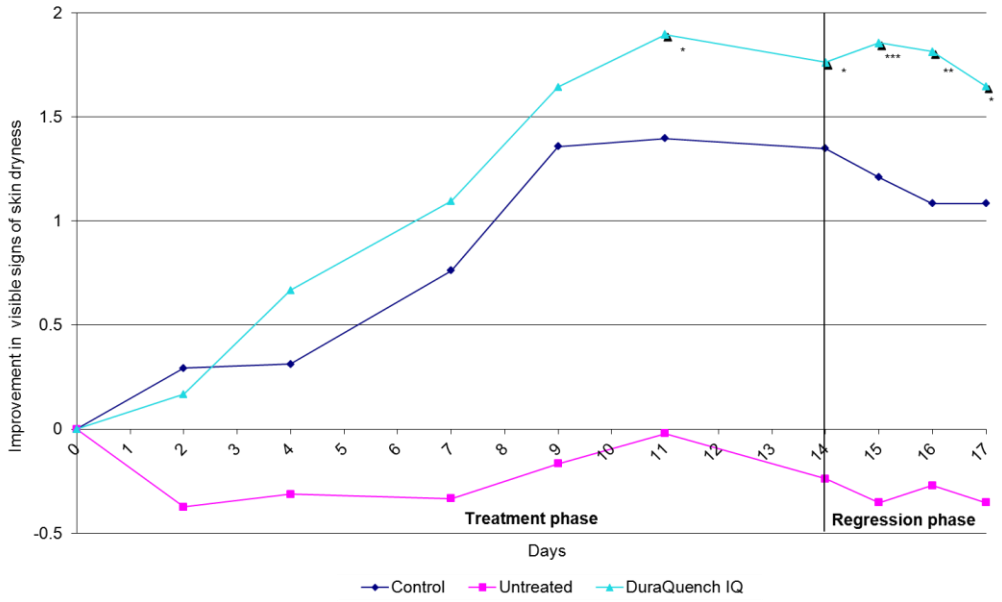


Figure 2: Significant improvement in visual dryness seen with the DuraQuench IQ formulation versus the control on day 11 (p<0.05) and 14 (p<0.05) of the treatment phase and day 1 (p<0.001), 2 (p<0.01) and 3 (p<0.05) of the regression phase.

Not only does the DuraQuench IQ formulation outperform the control by relieving the visible signs of skin dryness to a greater extent, it also performs at a significantly faster rate (p<0.01) throughout the treatment phase as shown in Figure 3. This is shown by measuring the average trend line gradient of the DuraQuench IQ and control results from Figure 2.

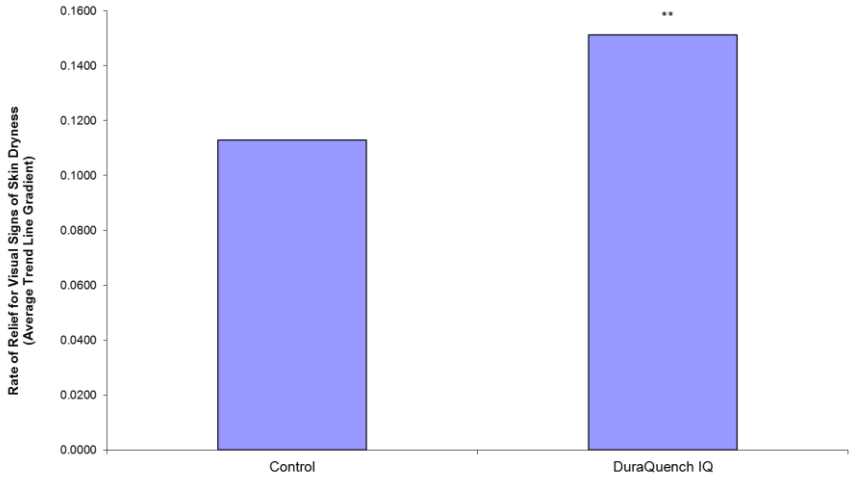


Figure 3: DuraQuench IQ significantly improves the visual signs of skin dryness at a faster rate than the control (p<0.01).

Using the same average trend line gradient analysis, Figure 4 shows that the DuraQuench IQ formulation significantly outperforms the control during the regression phase (p<0.05) with its ability to maintain the improvement in the visual signs of skin dryness. This shows that DuraQuench IQ imparts long lasting hydration of the skin which continues even when DuraQuench IQ is no longer applied.

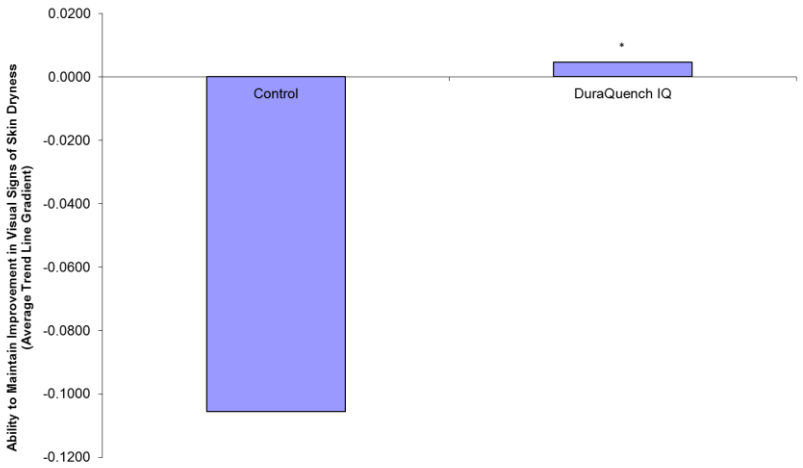


Figure 4: The DuraQuench IQ formulation significantly outperformed the control (p<0.05), maintaining a visible improvement in skin dryness.

Improvement in Skin Barrier Function

DuraQuench IQ improves inherent skin barrier function which can be seen in the results of a facial MET. Panellists entered a 4 day dry down phase, washing their face with soap while stopping the use of all moisturising products and any cosmetic products. Following this, the 14 day treatment phase consisted of applying the DuraQuench IQ and control formulations to each side of their face respectively while continuing to wash the face with soap. This was followed by a 5 day regression phase where panellists continued to wash their face with soap without application of the test moisturising creams.

Transepidermal water loss (TEWL) readings were taken on each side of the face on day 0 (baseline), 7 and 14 of the treatment phase, and on day 2 and 5 of the regression phase. The results in Figure 5 show the comparative net change in TEWL to baseline for the DuraQuench IQ formulation in comparison to the control. The results for day 7 ($p<0.05$) and day 14 ($p<0.01$) show a significant difference in TEWL for DuraQuench IQ in comparison to the control.

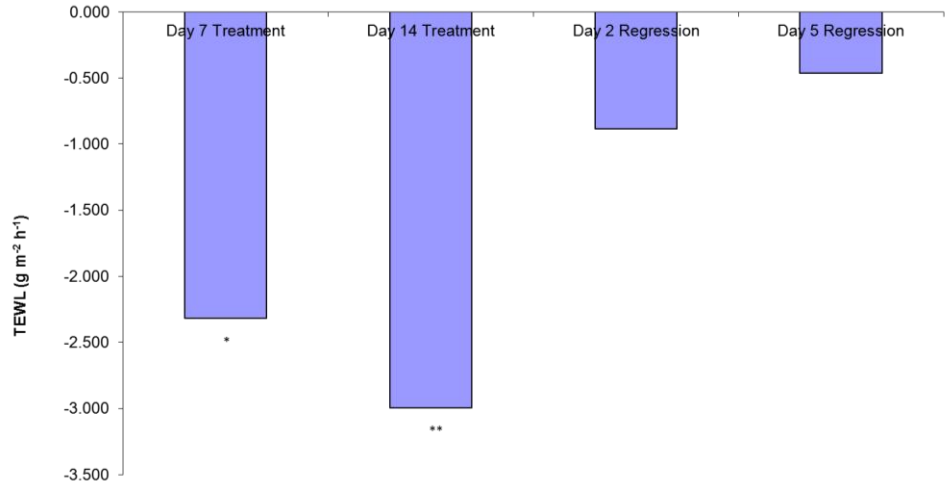


Figure 5: Comparative net change in TEWL to baseline for DuraQuench IQ in comparison to the control. Day 7 (p<0.05) and 14 (p<0.01) of the treatment phase both show a significant difference in TEWL.

Adhesive D-Squame discs, stained with multiple stain solution prior to analysis, were used to measure superficial skin dryness on day 0 (baseline), 7 and 14 of the treatment phase, and on day 2 and 5 of the regression phase. The results show a significant difference between the DuraQuench IQ and control formulations on day 14 of the treatment phase ($p<0.01$) and on day 2 of the regression phase ($p<0.01$).

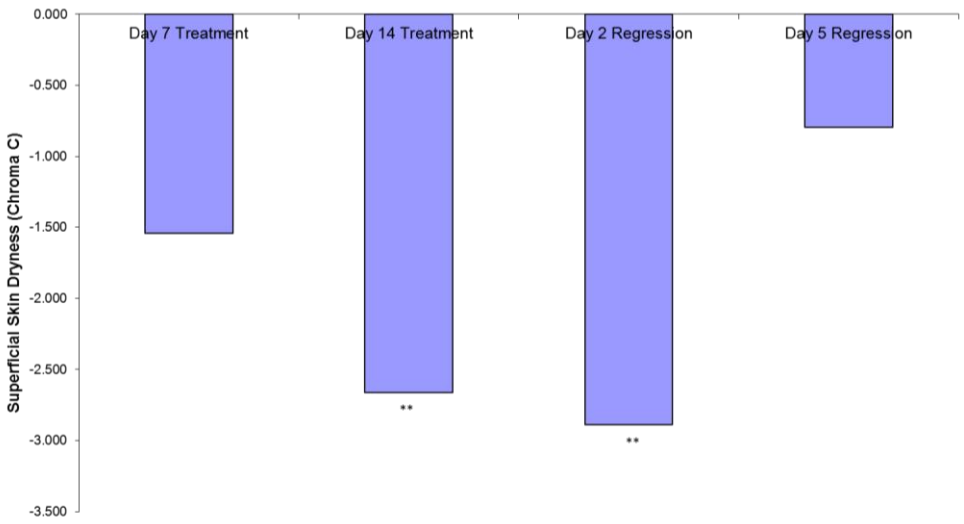


Figure 6: Comparative net change in superficial skin dryness to baseline for the DuraQuench IQ formulation in comparison to the control. Day 14 (p<0.01) of the treatment phase and day 2 (p<0.01) of the regression phase both show a significant difference.

The results of the facial MET demonstrate that DuraQuench IQ has a more immediate effect on inherent skin barrier function as measured by TEWL, which later leads to improvements in superficial skin dryness.

Temperature and Humidity Responsive

Skin hydration can be affected by a number of factors including sudden changes in environmental conditions, climate controlled environments and low humidity[1]. Seasonal variation also has an effect on the biophysical properties of the stratum corneum as a lower absolute humidity in winter causes a higher humidity gradient at the stratum corneum/air interface, favouring water loss which leads to dehydrated skin[3]. DuraQuench IQ has been developed to combat these changes in temperature and humidity via the formation of an intelligent structural layer on the skin, thereby reducing the impact of these environmental conditions.

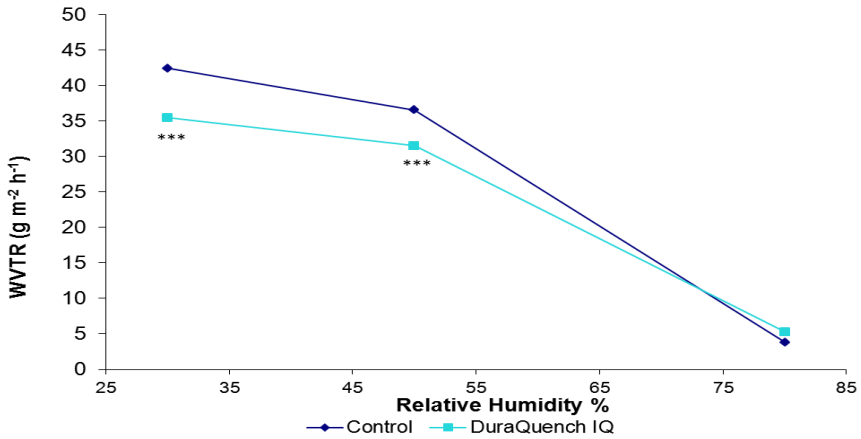
People around the world are exposed to varying temperatures and humidities on a daily basis as shown in Table 2. For example in Mexico City on the 1st January 2011, the temperature varied from a low of 7^{O}C to a high of 22^{O}C, and the relative humidity varied from a low of 15% to a high of 71%. Where extreme temperatures are present, skin is also exposed to air-conditioning and central heating which can lead to skin dryness.

	Temperature (^{O}C)		Relative Humidity (%)	
	High	Low	High	Low
Mexico City	22	7	71	15
Sao Paulo	24	18	94	65
Tokyo	10	2	57	29

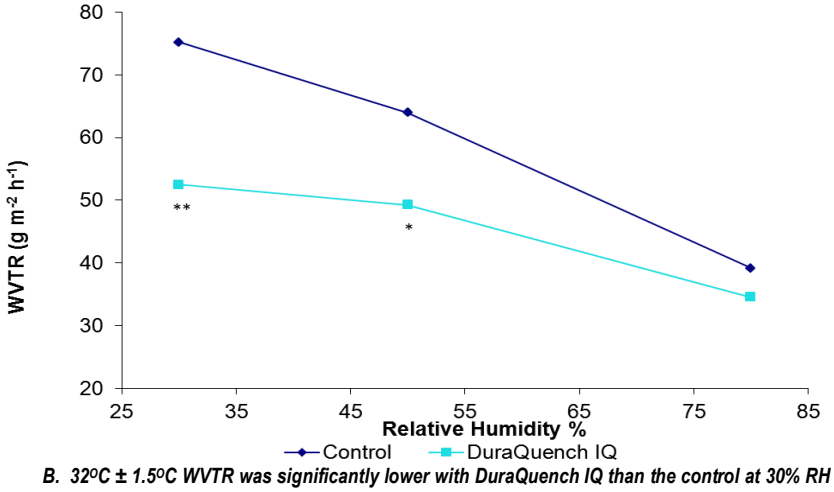
Table 2: High and low temperature (^{O}C) and relative humidity on the 1st January 2011.

In order to evaluate how DuraQuench IQ responds to varying temperatures and humidities, a thin film of the DuraQuench IQ and control formulation were dried onto a porous skin substitute (Vitro-corneum). Samples were analysed using a water vapour transport rate (WVTR) method at 20 ^{O}C, 32^{O}C and 40 ^{O}C (±1.5^{O}C) at 30%, 50% and 80% (± 5%RH) relative humidity respectively (32 ^{O}C represents surface skin temperature). The results of the WVTR were normalised as a percentage relative to the residual film weights.

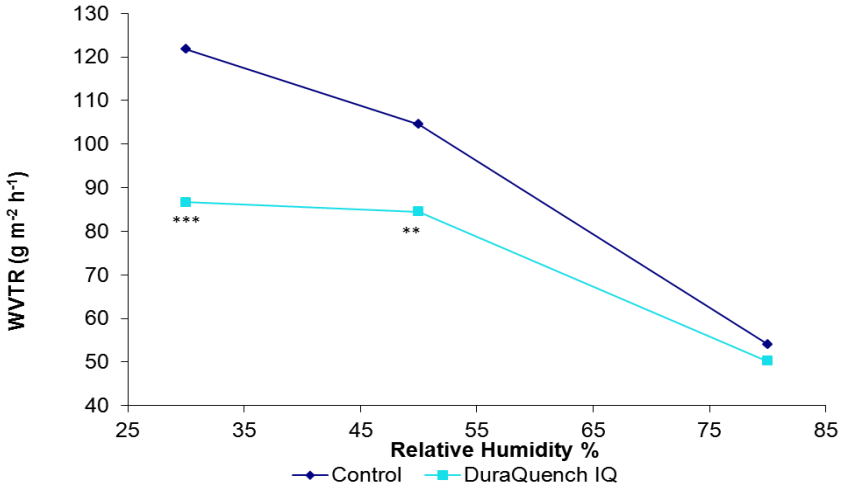
The results of the WVTR test show that at 20 ^{O}C, 32^{O}C and 40 ^{O}C, the formulation with DuraQuench IQ reduced water loss significantly versus the control formulation at 30% and 50% humidity, as shown in Figure 7. This shows that DuraQuench IQ can impart temperature and humidity responsive properties for optimised moisturisation benefits.



A. 20°C ± 1.5°C. WVTR was significantly lower with DuraQuench IQ than the control at 30% RH (p<0.001) and 50% RH (p<0.001).



B. 32°C ± 1.5°C WVTR was significantly lower with DuraQuench IQ than the control at 30% RH (p<0.01) and 50% RH (p<0.05).



C. 40°C ± 1.5°C. WVTR was significantly lower with DuraQuench IQ than the control at 30% RH (p<0.001) and 50% RH (p<0.01).

Figure 7: WVTR normalised for residual film weights at 20°C, 32°C and 40°C tested at 30%, 50% and 80% Relative Humidity.

Intelligent Structure

X-ray diffraction can be used to give an indication of the lipid structure that an emulsion forms on the skin. Wide angle x-ray diffraction (WAXD) provides information about the smaller structural units in a sample, such as the lateral packing in a lamellar phase. Small angle x-ray diffraction (SAXD) provides information about larger structural units in a sample, such as the periodicity in a stack of bilayers (bilayer to bilayer distance).[4] In this study, the DuraQuench IQ and control formulation were compared using WAXD and SAXD.

The results from the WAXD show that the control sample with 1 hour drying at 32˚C has two peaks, one at 0.47nm (a) and one at 0.40nm (b). In comparison, the DuraQuench IQ sample with 1 hour drying at 32˚C has two prominent peaks in a more tightly packed 0.42nm (c) and 0.38nm (d) orthorhombic phase. This repeat distance is very similar to that of the natural skin lipids, 0.41nm and 0.37nm. The lateral packing of membranes determines permeability which explains why the residual phase from the DuraQuench IQ sample is more effective at controlling transepidermal water loss than the control.

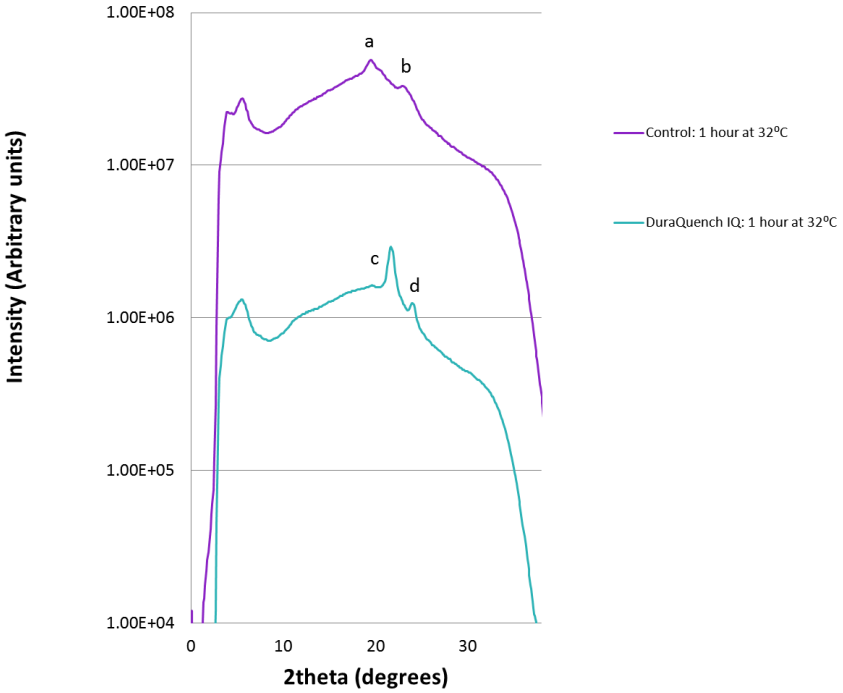


Figure 8: Wide Angle X-ray Diffraction (WAXD) of the DuraQuench IQ and control formulations which have undergone 1 hour drying at 32°C. Lateral packing of the DuraQuench IQ formulation is much tighter than the control formulation.

The results from the SAXD show that the control sample with 1 hour drying at 32˚C has a single peak at 5.0nm (a). It is likely that this is the first reflection of a bilayer structure. In comparison to the control, the DuraQuench IQ sample shows two much broader reflections, one at 5.0nm (b) and one at 10.0nm (c). It is thought that these

are the 1st and 2nd order reflections of a stack of bilayers, and the higher spacing in the DuraQuench IQ sample compared to the control is due to a thicker bilayer, which is important for improved barrier function.

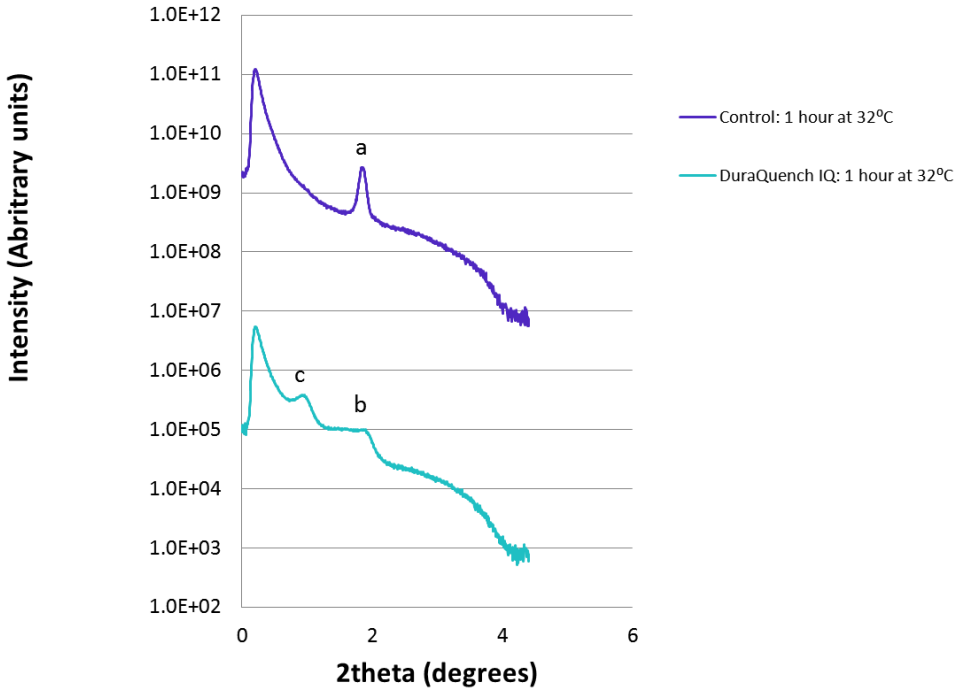
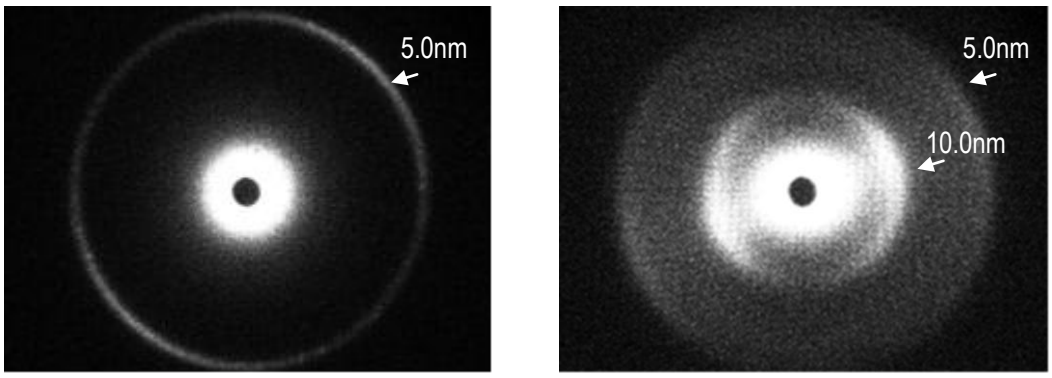


Figure 9: Small-angle x-ray Diffraction (SAXD) of the DuraQuench IQ and control formulations which have undergone 1 hour drying at 32°C. The results show that the formulation containing DuraQuench IQ forms bilayers which are thicker than the control formulation.

Images from the SAXD show a narrow 5.0nm band in the control sample, whereas the image of the DuraQuench IQ sample shows an additional, broader band at 10.0nm representing a thicker bilayer (Figure 10).



Control ***DuraQuench IQ***

Figure 10: SAXD images showing that a 5.0nm lipid bilayer is present in the control formulation while 5.0nm and 10.0nm bilayers are present in the DuraQuench IQ formulation.

The SAXD and WAXD results support the theory that DuraQuench IQ forms an intelligent lipid structure on the surface of the skin, similar to that found within healthy skin.

Consumer Sensory Perception

To evaluate consumer sensory perception of DuraQuench IQ, a panel study was carried out and panellists were asked to apply a formulation with and without DuraQuench IQ to either side of their face respectively for 1

week. The panellists were asked to complete a pre- and post- study questionnaire. The results of the study show that 71% of panellists preferred the formulation containing DuraQuench IQ. Panellists also observed a significant improvement in skin smoothness (p=0.0273) and skin radiance (p=0.0674) versus the control formulation as seen in Figure 11.

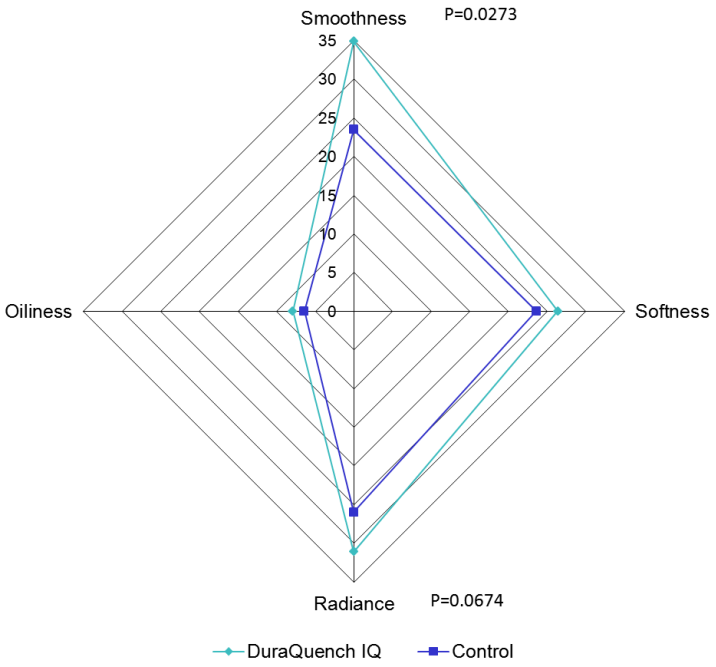


Figure 11: Consumer perception percentage change in smoothness, softness, radiance and oiliness after 1 week of application of the DuraQuench and control formulation to either side of their face respectively. Smoothness (p=0.0273) and radiance (P=0.0674) increased significantly using the DuraQuench IQ formulation versus the control.

The significant increase in skin smoothness and radiance, seen using the DuraQuench IQ formulation, can be linked to skin hydration as there is a correlation between the level of skin hydration and the amount of light absorbed or scattered by the skin. In dehydrated skin, an increased amount of light is scattered at the skin surface due to the raised edges of corneocytes, whereas in hydrated skin, more light penetrates into the deeper skin layers resulting in darker, more pinkish and more translucent skin.[5]

References:

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2.Scott. Retinoic Acid – Still the Ultimate Benchmark. 2002, 22nd IFSCC Congress, Edinburgh.

3. Black D et al. Seasonal variability in the biophysical properties of stratum corneum from different anatomical sites. Skin Research ad Technology 2000; 6: 70-76.

4. Bouwstra JA and Ponec M. Review: The skin barrier in healthy and diseased state. Biochimica at Biophysica Acta 2006 2080 – 2095.

5.Jiang Z.-X. and DeLaCruz J. Appearance Benefits of Skin Moisturization. Skin Research and Technology 2011;17:51-55.