

Article

An Exploratory Study of Consumers' Knowledge and Attitudes about Lignin-Based Sunscreens and Bio-Based Skincare Products

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Supplementary Materials:

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Familiarity, purchasing intention, and attitude towards bio-based ingredients for skincare products

Dear participant,

we are a group of researchers from InnoRenew CoE and the University of Primorska, Slovenia, that is interested in developing healthier and more sustainable ingredients for skincare products aimed at sun protection.

You are invited to fill out a 10–15-minute survey about the usage of skincare products, their impact on our health and environment, and the perception and attitudes towards bio-based ingredients in skincare products. Your valuable input will support research and the development of an innovative, sustainable, bio-based sunscreen ingredient. Your participation in the survey is completely anonymous and voluntary, and you can withdraw from the study at any time without giving any reason. The obtained data will be anonymized and used for research and education purposes only. Questions about the study can be sent to oihana.gordobil@innorenew.eu.

Thank you for your participation!

Please read carefully the informed consent document and indicate below whether you agree with collecting your survey data. Privacy policy and general terms are available on this link. By clicking the option Yes, I agree with collecting my data, you confirm your agreement that:

- you have read all sections in the informed consent document,
- you understand your participation is voluntary and can be withdrawn at any time,
- you understand your words may be quoted in publications and other research outputs,
- you understand your personal data will be kept securely and available only to authorized personnel, and
- you understand anonymised research data will be archived and may be used by third parties.

- a) Yes, I agree with collecting my data
b) No, I do not agree with collecting my data

Q1 - How often do you use the following skincare products?

	Never (0% of days)	Rarely (10-20% of days)	Sometimes (30-50% of days)	Often (60-80% of days)	Always (90-100% of days)	Don't know
Cleanser						
Moisturizer on the face						
Moisturizer on the body						
Repair or anti-ageing products (antioxidants, serums, exfoliators...)						
Sunscreen on the face						
Sunscreen on the body						

Q2 - How often do you use sunscreen in the following conditions?

	Never (0% of days)	Rarely (10-20% of days)	Sometimes (30-50% of days)	Often (60-80% of days)	Always (90-100% of days)	Don't know
On warm sunny days						
On cloudy days						
At the beach						
During recreation (e.g., jogging, cycling, walking, hiking)						
While doing outdoor domestic chores (e.g., lawn						

mowing, snow removal, gardening)						
While doing outdoor job-related tasks (e.g., construction work, delivery)						

Q3 - What SPF (sun protection factor) do you normally use in the following conditions?

	SPF lower than 15	SPF 15-29	SPF 30-49	SPF 50 and higher	Does not apply	Don't know
On the face on warm sunny days						
On the face on cloudy days						
On the rest of the body on warm sunny days						
On the rest of the body on cloudy days						

Q4 - How often do you reapply your sunscreen?

	Never	Once	Multiple times	After swimming or sweating	Not relevant	Don't know
On a normal day						
At the beach						
In the mountains						
When spending half a day or more outdoors						

Q5 - What type of protection does your sunscreen usually have?

- a) Protection only from UVA rays
- b) Protection only from UVB rays
- c) Protection from both UVA and UVB rays (broad-spectrum)
- d) Don't know
- e) I do not use sunscreen

Q6 - What type of formula do you usually prefer when using sunscreen products?

- a) Lotions (lighter and non-greasy consistency, easily absorbed into the skin)
- b) Creams (thicker and greasier consistency when applied to the skin)
- c) I do not have a preference
- d) Don't know
- e) I do not use skincare products

Q7 - Did you ever have an allergic or irritant reaction to a skincare/sunscreen product?

- a) Yes
- b) No
- c) Don't know

Q8 - When buying sunscreen, what properties are the most important to you? Please choose the properties that have the greatest weight in your decision to buy sunscreen from the left column and drag them to the right column from most important (first place) to least important (last place). If some of the listed properties are not important to you at all, you can leave them in the left column.

Available categories:

Price
Brand
Ingredients being natural
Texture
Fragrance
Colour
Quality
Packaging
Novelty of the product
Vegan/cruelty-free

Ranked categories:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Q9 - The following statements refer to your attitude towards skincare in general and use of sunscreen. There are no right or wrong answers, so please rate the degree to which you agree or disagree with them based on your beliefs.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Don't know
Solar radiation is harmless.						
Having a tan is healthy.						
Skincare products help to fight the effects of ageing.						
Use of sunscreens can prevent sunburns, skin damage, skin ageing and skin cancer.						
The official recommendation is to always use a broad-spectrum sunscreen with SPF 50 or higher.						
I usually check the ingredients of the products when buying it.						
I tend to buy skincare products with ingredients of natural origin.						
Artificially made/synthetic ingredients are more efficient than natural ingredients.						

Q10 - The following statements refer to the connection of ingredients in skincare to our health and the environment. There are no right or wrong answers, so please rate the degree to which you agree or disagree with them based on your beliefs.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Don't know
Ingredients from skincare and sunscreen products are being continuously released into the environment.						

Synthetic UV filters, antioxidants and preservatives are common ingredients in skincare.						
Chemicals from skincare products tend to accumulate in living organisms.						
Chemicals from skincare products have been detected in human fluids, such as urine, semen, breast milk and the bloodstream.						
Chemicals from skincare products are harmless to ecosystems.						
Chemicals can cause dermatological side effects (skin allergies or irritation).						
In addition to the origin of the ingredients, a sustainable way of their production is also important.						
Skincare interests me.						
The environmental impact of synthetic ingredients concerns me.						
I take good care of my health.						
Protecting and preserving the environment should have priority over economic growth and development.						

Q11 - Research has shown that synthetic (artificially made) ingredients used in sunscreens are harmful to corals and other marine life. Have you ever heard about this information? Choose all options that apply. Multiple answers are possible.

- a) On the radio
- b) On the television
- c) From friends and/or family
- d) From researchers/research institutes
- e) From a relevant official/government body
- f) On a blog on the Internet
- g) On social media
- h) On a news page
- i) No, I have never heard about this before
- j) I do not know/remember
- k) Other: _____

Q12 - Is there any ingredient that you usually try to avoid in skincare? If yes, which one(s)?

- a) No
- b) Yes: _____

Q13 - What does bio-based mean to you? Choose the property from the word pair that you associate more with the term “bio-based”. Please do not change your choices after you learn more about the term.

Traditional	or	Innovative
Wholly derived from biological materials	or	Partly derived from biological materials
Derived from animals	or	Derived from plants
Unsafe	or	Safe
Non-organic	or	Organic
Environmentally friendly	or	Depletion of natural resources
Affordable	or	Luxurious
Higher toxicity	or	Lower toxicity
High quality	or	Poor quality
Better for my health	or	Better for the environment
Non effective	or	Effective

Q14 - Please choose the answer that best describes how familiar you were with the following subjects before this survey.

	I have never heard about it before	I have heard about it, but do not know much of it	I am familiar with the topic	Don't know
Lignin				
Bio-based ingredients (substances of natural origin) for skincare				
Biopolymers (large molecules from plants or animals) from nature can be used as an ingredient for skincare and sun protection products				
Natural biopolymers can be obtained from wood and plants, but also from renewable sourced leftover (residue) and waste materials from the industry				

Q15 - Would you like to have more information about bio-based ingredients for skincare products?

- a) Yes
- b) No
- c) Don't know

Q16 - The following statements refer to your perception of bio-based ingredients and their connection with the environment. There are no right or wrong answers, so please rate the degree to which you agree or disagree with them based on your beliefs.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Don't know
The use of bio-based ingredients in skincare products would have a positive impact on the environment.						
Plant-derived ingredients cannot replace synthetic ingredients.						

Skincare products containing bio-based ingredients are healthier for my skin than products with synthetic ingredients.						
I am willing to pay more for a bio-based skincare product if it is free of chemicals.						
Skincare products with bio-based ingredients are usually more expensive than synthetics.						
Good functionality/performance is what matters, not the origin of the ingredients.						
I prefer conventional chemical ingredients over bio-based ingredients.						
I will buy skincare products containing mainly bio-based ingredients in the future.						
Obtaining bio-based ingredients from agricultural waste is innovative.						
I would not want to use skincare/suncare products that are brownish in colour.						

Q17 - Choose the property that you associate more with the term “lignin”. Please do not change your choices after you learn more about the term.

Natural origin	or	Synthetic origin
Renewable	or	Non-renewable
Affordable	or	Expensive
Toxic	or	Safe
Derived from plants	or	Derived from animals
Low availability	or	Industrially available

Q18 - Lignin is an abundant natural substance that can be found all over the world in trees and plants and is usually a by-product left over after manufacturing pulp and paper.

On one hand, it has a lot of beneficial properties that can be very useful in skincare – it can act as a broad-spectrum sun-blocker (protecting from both UVA and UVB rays), an antioxidant, and a preservative due to its’ antimicrobial nature. Using it as a bio-based active ingredient to replace some currently used synthetic ingredients in skincare products could decrease their accumulation and harmful effects on our health and environment in an economic way. On the other hand, lignin has intense dark pigmentation and every product containing it will have a light brown colour. Additionally, on its own, lignin can only reach a sun protective factor (SPF) value of 10 and researchers are still working on an efficient, safe, and sustainable way to increase the SPF.

Would you buy a skincare product containing this ingredient?

- a) Yes
- b) Probably
- c) Maybe
- d) No
- e) Don’t know

Q19 - Can you briefly describe your thoughts and reasons for (not) wanting to buy this product?

Q20 – Please specify your age: _____

Q21 – Which of the following best describes you?

- a) Woman
- b) Man
- c) Non-binary
- d) Transgender
- e) Not listed (please specify): _____
- f) Prefer not to answer

Q22 – What is the highest degree or level of school you have completed?

- a) Primary education
- b) Secondary education
- c) Bachelor's degree (first Bologna cycle or equivalent)
- d) Master's degree (second Bologna cycle or equivalent)
- e) Doctorate degree or equivalent
- f) Other (please specify): _____
- g) Prefer not to answer

Q23 – Are you currently...?

- a) A student
- b) Employed
- c) Unemployed
- d) Retired
- e) Other (please specify): _____
- f) Prefer not to answer

Q24 – What is your country of residence? _____

Q25 – How would you describe your financial standing compared to others in your country?

- a) Very good
- b) Good
- c) Fair
- d) Poor
- e) Very poor
- f) Prefer not to answer

Q26 – Which of the following options best describes your skin and its typical reaction to the first unprotected sun exposure in the summer?

- a)  Type 1: Always burns, tans minimally (very pale, white)
- b)  Type 2: Burns easily, tans minimally or with difficulty (light)
- c)  Type 3: Burns sometimes, tans gradually (slightly darker)
- d)  Type 4: Burns rarely and minimally, tans with ease (olive)
- e)  Type 5: Burns very rarely, tans very easily (brown, dark brown)
- f)  Type 6: Never burns, tans very easily (dark, black)
- g) Other: _____
- h) Prefer not to answer

You have answered all the questions in this survey. Thank you for your participation! If you have any questions about the research or you are interested in the results, send an email to oihana.gordobil@innorenew.eu.