

Study on food related perceptual experience of colour blind people

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The study intends to investigate how colour blind individuals perceive food-related events. A widespread eyesight disease called colour blindness is thought to afflict 0.5% of women and 8% of men globally. Despite being common, little study has been done on how colour blindness affects experiences with food. By examining the difficulties colour blind people have recognising and distinguishing the colours of foods, and the methods they employ to get around these difficulties, the research aims to close this gap. To gather information from people who are colour blind, the study will use qualitative methodologies, such as in-depth interviews and focus group discussions. To find struggles and strategies, the data will be thematically analysed. The study's conclusions will have a significant impact on the food industry since they will guide the creation of more accessible and inclusive food items that are tailored to consumers who are colour blind.

Keywords: colour blindness, food experiences, food purchase, food consumption, food preparation

1 Introduction

Colour blindness is a colour vision deficiency in which humans lose the ability to see one of the three colours: red, blue, green or resulting colour from mixing them together. This deficiency makes people see colours differently than others and make it difficult for colour blind people to distinguish between objects based on their colour. Colour blindness makes day-to-day activities difficult for the people. There are an estimated 300 million people in the world with colour vision deficiency. Every 1 in 12 men, i.e, 8% are colour blind and 1 in 200 women, i.e. 0.5%, are colour blind. More men are affected by colour blindness than women as it is inherited genetically and carried recessively by X-chromosome.

The inability to distinguish between colours can mislead people and can cause many day-to-day problems in the effortless activities for people with normal vision. One of them is inability to differentiate between food items, this can lead to health issues. For example, those who are colour-blind could have trouble telling when fruits and vegetables are ripe, judging when meat is

cooked, and preparing meals that seem pleasant. Also, colour blindness can affect how food safety procedures are carried out since those who are colour blind might find it challenging to recognise potentially harmful meat that is not fully cooked. Considering the possible effects of colour blindness on dietary preferences and safety procedures, little research has been done on the subject. In order to identify potential obstacles and create solutions for them, the goal of this study is to analyse the perceptual experience of colour-blind people with regard to their food preferences and safety practices. Though there are ways through which colour blinds can distinguish food items but still missing out on small differences can cause massive problems. The food related behaviour, pattern and experience of colour blind people have to be properly studied to figure out the minute problems caused by colour deficiency.

1.1 Objectives

- To observe food experience and eating patterns of people suffering from colour blindness.
- To analyse problems colour blindness cause in food related experience of affected people.

2 Review of literature

2.1 Colour

Our brain has billions of neurons cooperatively working to provide the illusion of colour vision. There is no colour in the real world; rather, colour is a projection of neurological processes onto the world we perceive. It is closely related to the sense of form, where colour makes it easier to see object edges. Two characteristics of light, energy and frequency of vibration or wavelength, are used to generate colour(Gouras, 2009). Light's interactions with objects and the human eye give rise to the visual perception of colour. As light strikes an item, some of the light's wavelengths are absorbed while others are reflected by the object. The human eye then detects the light wavelengths that have been reflected, analyses the data, and generates a perception of colour.

Hue, saturation, and brightness are the three major characteristics used to characterise colour. Hue, which is the particular wavelength of light that is seen, is what separates various colours from one another (e.g., red vs. blue). Colour purity or intensity is referred to as saturation, and it can range from being extremely pure (high saturation) to muted or washed out (low saturation). Brightness is a term used to describe how light or dark a colour is generally, and it can range from being extremely bright to being very dark (low brightness).

Due to the existence of specialised cells in the retina of the eye called cone cells, humans are able to perceive a wide variety of colours. These cone cells, which are sensitive to various light wavelengths, combine to produce the entire spectrum of colours that people can see.(Brainard, D. H. (2003)

2.2 Observation of colour

Cone cells, specialised cells in the retina of the eye, are what enable colour vision, the mechanism by which humans perceive colour. Cone cells come in three varieties: short-wavelength (S) cones, which are sensitive to blue light; medium-wavelength (M) cones, which are sensitive to green light; and long-wavelength (L) cones, which are sensitive to red light. These cone cells are stimulated when light enters the eye, and they then send signals to the brain that the brain interprets as colour.(Palmer, S. E., Schloss, K. B., & Palmer, J. (2010))

The three different types of cone cells' impulses are then combined by the brain to produce the entire spectrum of colours that people can see. Trichromatic colour vision is the process that underlies the majority of human colour perception.

However for certain individuals, a colour vision impairment might make it challenging to discern between specific hues. This may be brought about by a number of things, such as retinal or optic nerve damage or genetic abnormalities that alter the sensitivity of cone cells.(Palmer, S. E., Schloss, K. B., & Palmer, J. (2010))

2.3 Colour blindness

A lack or absence of specific kinds of cone cells in the retina causes colour blindness, which impairs the ability to distinguish between specific hues of colour. Red-green colorblindness, which affects the sensitivity of the long-wavelength (L) and/or medium-wavelength (M) cone cells, is the most prevalent kind of colour blindness.

These cone cells typically contain photopigments, which are sensitive to particular light wavelengths. Unlike the M-cones, which contain the photopigment chlorolabe, which is most sensitive to medium-wavelength light, the L-cones contain the photopigment erythrolabe, which is most sensitive to long-wavelength light (i.e., red) (i.e., green). The erythrolabe and/or chlorolabe photopigments are either absent or aberrant in patients with red-green colorblindness, which reduces their capacity to discern between red and green hues. Red-green colour blindness comes in a variety of forms depending on which photopigments are impacted. The erythrolabe photopigment is completely absent in protanopia, making it impossible to discriminate between red and green hues. The chlorolabe photopigment is completely absent in deuteranopia, which also makes it difficult to distinguish between red and green colours. The erythrolabe and chlorolabe photopigments are present but aberrant in protanomaly and deuteranomaly, which reduces the capacity to discriminate between red and green colours. (Kalloniatis, M., & Luu, C. (2021))

Types of colour blindness

- Protanopia: This form of colorblindness alters how red light is perceived. Protanopia patients report diminished or absent red colours.
- Deuteranopia: This form of colorblindness alters how green light is perceived. Deuteranopia patients report a diminished or absent green coloration.

- Tritanopia: This form of colorblindness alters how blue light is perceived. Blue colours are diminished or completely absent for those who have tritanopia.

Subtypes of colorblindness exist in addition to these primary types, and they have an impact on how different colours or colour combinations are perceived. People who have achromatopsia, for instance, are entirely unable to see colour and only see shades of grey.



Figure 1: Perception of colour by Normal colour visioned, Deutan colour blind person, protan colour blind person and achromatopsia colour blind person. Source: enchroma.com

2.4 Causes of colour blindness

The majority of the time, colour blindness is inherited, which means it is handed down through generations from parents to their offspring. Genetic mutations that alter the photopigments in the cone cells of the retina result in colour blindness.

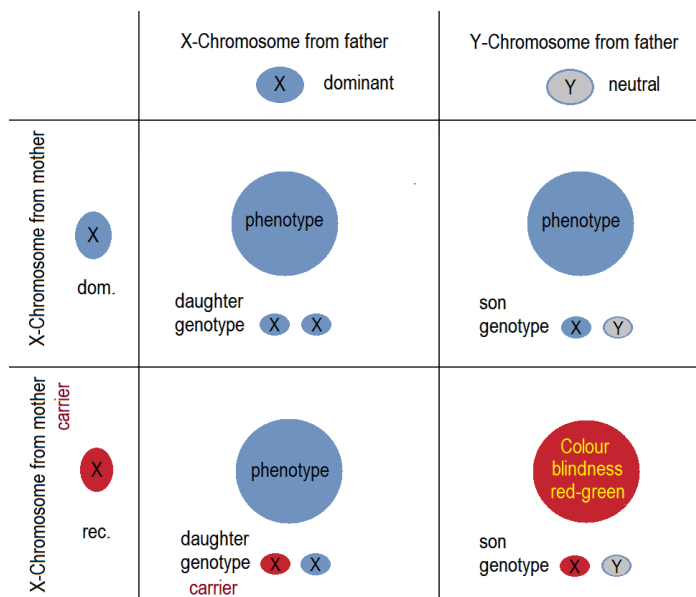


Figure 2: Genetic Inheritance of colour blindness. Source: Wikimedia Commons

On the X chromosome reside the genes that regulate the photopigments in the cone cells of the retina, which are responsible for colour vision. Males only have one X chromosome, thus if they receive a mutant gene from their mother on that chromosome, they will become colour blind. Contrarily, females have two X chromosomes. They need to inherit two defective genes, one from each parent, or have one mutant gene and one gene that generates a normal photopigment in order to become colour blind. Females are less likely to be entirely colorblind than males under such circumstances, yet they may have less of an ability to discern between colours.

2.5 Problems associated with food consumption.

In a study it was discovered that chefs and kitchen staff's procedures regarding food safety were significantly impacted by colour blindness. According to the study's findings, those who are colour-blind might have trouble telling the difference between cooked and raw meat, which could constitute a risk to food safety if it is not properly recognised and treated (Nennstiel et al., 2015). Another study that looked at the effect of colour blindness on food presentation discovered that those who are colour blind may have trouble selecting which colours to utilise for food presentation's aesthetic appeal (Dobromir et al., 2020). This may limit their capacity to provide aesthetically pleasing meals and affect how much they enjoy their cuisine.

Colour-blind people may have trouble with some foods, particularly those that depend on colour to indicate ripeness or readiness to eat, when it comes to identifying ripe fruits and vegetables. For instance, people who are red-green colour blind may find it challenging to tell the difference between ripe and unripe tomatoes, bananas, and strawberries, among other fruits and vegetables (Mollon, 1986).



Figure 3: Day-to-day activities and materials as perceived by individuals having a) normal colour vision and b) CVD. Source: onlinelibrary.wiley.com

Overall, colour blindness can have an impact on the display, choice, and safety of food. To create solutions to overcome these issues and to better understand the connection between colour blindness and food challenges, more research is required.

3 Research Methodology

A mixed-methods approach will be used in the study to examine how colorblind people perceive and enjoy food. Online surveys and focus groups are used as online qualitative research methods.

3.1 Sampling

Purposive sampling will be used as a sampling technique to find participants who self-identify as colorblind. By using purposive sampling only participants who identify themselves as colourblind will only participate.

Demographics: The study will focus on those who have been diagnosed with colour blindness and are at least 13 years old. Participants can speak and comprehend English. The sample may be gathered through social media sites and online forums, which might produce a sample that is varied in terms of age, gender, and region.

3.2 Data collection

3.2.1 Online Survey

The survey was conducted through online mode by using google forms. Total number of participants were 7, all were males and between the ages of 13-25 years. 6 participants identified themselves as red-green colour blind where as 1 participant was complete colour blind.

Each participant will be required to complete a thorough case study that will include details about their background, colorblindness experiences, and particular food-related difficulties they have encountered. The survey will also examine the participant's responses to these difficulties and any management techniques they may have devised.

Survey Questions:

Survey will be divided into 5 sections: General information about participants, Food Shopping Experience, Food cooking experience, Eating experience and Others, which will have their suggestions and permission to contact.

All the questions are either multiple choice or short paragraph answers.

Questionnaire

Section 1: General Information

What type of colour blindness do you have?

- Red-green
- Blue-Yellow
- Complete

At which age you found out you are colour blind?

How colour blindness affects your daily life?

Section 2: Shopping

Do you prefer online shopping over in-store shopping?

- Yes
- No

Can you tell the challenges you face in grocery shopping due to colour blindness? Example: Being unable to find a specific product or need any assistance

Have you ever faced difficulty in differentiating food packets on the basis of colours? Mention any product you had such experience with.

Any approach you have taken to resolve these issues?

Do you find differentiating cereals difficult

- Yes
- I could not on the basis of colours but on the basis of texture and shape I can
- No

Have you ever had any issues with online grocery shopping, such as difficulty navigating colour-coded interfaces or making errors in ordering due to colour confusion?

- Yes
- Sometimes
- No

Have you faced difficulty in differentiating if the fresh produce food items(Milk or meat) are fresh or stale?

- Yes
- Sometimes
- No

Section 3: Cooking

How often do you cook?

- Daily
- Once or twice a week
- Rarely
- I don't but have tried in the past

Are there any particular types of foods or ingredients that you find particularly challenging to identify? Mention some that you can remember.

Example: Mistaking a food for a different type or being unable to identify ingredients in a recipe.

Do you find it difficult to differentiate between cooked and uncooked food(on the basis of colour)?

- Yes
- Sometimes
- No

How do you typically approach food identification to minimise the impact of colour blindness? (Can choose multiple options)

- Rely on smell
- Rely on taste
- Rely on texture
- Rely on shape or forms
- Rely on labels
- Colour coding
- Assistance
- all

Section 4: Eating the food

How often do you dine out or order food

Has it ever happened that you don't want to eat something cause the way it looked colour wise?

- Yes
- No

Have you ever had any health issues? Example: Indigestion cause you could not recognise if the food is fine to eat

Have you ever failed to identify any allergen in food because of colour blindness and faced any allergic reaction?

- Yes
- No

Section 5: Others

Imagine if you want to be a chef, do you think colour blindness will be an issue?

- Yes
- Maybe but not major
- No

Do you think the food industry and restaurants should consider constraints of colour blindness? Give your views in a line or two

Will you use an app which can identify fresh-stale, cooked-uncooked and different ingredients for you?

- Yes
- Yes but i can figure it anyways
- No

Any suggestions?

Like: Something I can touch upon in my study or Your views

Can I contact you if I need any help related to the same research?

- Yes
- No

Please provide your contact number if you are fine.

What is your name and age?

What are you currently doing?(Student/Job)

3.2.2 Online Focus Group:

The text-based discussion was done on focus groups of colour blindness on Reddit and Facebook. The participants of various age groups, occupations and regions shared their insights.

Discussion prompts

- Your views on how food perception is affected in case of Colourblindness
- Does colour blindness affect food preferences?
- Do you think colour blindness can risk your health if you eat unprepared food?

Discussion groups: Reddit- r/colourblind and Facebook-Colour blindness and colour vision deficiency awareness

3.3 Data Analysis

Analysis of the data from the survey and focus group discussion would be done using a thematic approach, according to the study. To analyse the data, food habits and related activities were divided into major three categories: Purchasing, Cooking and Eating. The problems faced by individuals that arose during discussion or from the survey were categorised accordingly. And the strategies that participants used were also analysed. The suggestions and ideas of the participants were also taken into consideration.

3.4 Ethical considerations

Prior to data collection, participants will be fully informed about the study and their consent will be acquired. Additionally, the study will abide by ethical principles and practises to protect participant anonymity and privacy.

3.5 Limitations

The study's sample size is rather small, which could restrict how broadly applicable the results can be. Furthermore, the study's use of self-reported data raises the possibility of bias or inaccuracy in the findings.

3.6 Implication

The study's conclusions may have an impact on how food is packaged and labelled, how food safety procedures are carried out, and how much the general public is aware of colorblindness and how it affects their daily lives.

4 Research Findings

The results of the study imply that colour blindness significantly affects a person's capacity for navigating the world of food. The difficulties that participants reported having with food shopping, preparing meals, and eating led to dissatisfaction, worry, and a reduced pleasure of food in the end.

4.1 Problems faced

The problems faced by participants were analysed on the basis of three types of activities related to food consumption

Purchasing food items

- The participants mentioned that choosing the appropriate goods when buying food was challenging because of perplexing labelling, packaging, and signage.

- Certain meals or items' colours were difficult to identify, which made selections about what to buy confusing.

Have you faced difficulty in differentiating if the fresh produce food items(Milk or meat) are fresh or stale?

7 responses

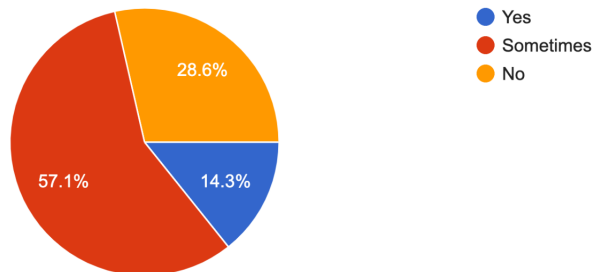


Figure 4: More than 60% of the respondents faced difficulty in differentiating between fresh and stale products. Source: Survey done Link

- Participants also mentioned that they frequently ask family members or store personnel for advice while buying food.



Figure 5: Tropicana juice present in multiple flavours. Packaging can be confusing for colour blind people. Source: Self

Cooking meal

Do you find it difficult to differentiate between cooked and uncooked food(on the basis of colour)?

7 responses

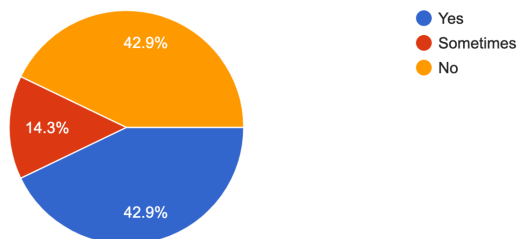


Figure 6: 57.2% of the participants at times could not differentiate between cooked and uncooked food. Source: Survey done Link

- The participants mentioned having trouble telling apart different colours and components in recipes when they were cooking.
- Some participants claimed they had trouble making recipes that called for particular kinds of components because they couldn't discern the difference between different varieties of potatoes or onions and also got confused between lemons and oranges of the same size.
- Due to their inability to distinguish between various colours of pink or red, participants also reported trouble cooking meat to the correct level of doneness.



Figure 7: Red chilli(red-coloured) and turmeric(yellow coloured) are hard to differentiate due to colour blindness. Source: Pxhere

Eating

- The participants said that they felt reluctance to eat the food because of its appearance

Has it ever happened that you don't want to eat something cause the way it looked(colour-wise)?

7 responses

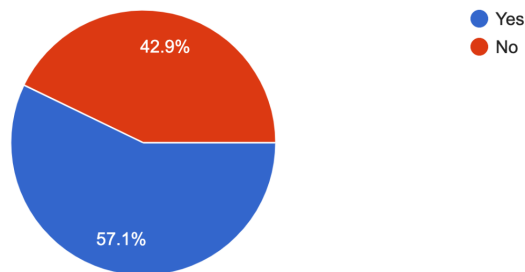


Figure 8: 60% of the participants had faced a situation where they felt reluctant to eat because of the way it looked. Source: Survey done Link

- Some participants failed to identify if the fruit or vegetable was good to eat. Some can't differentiate between ripe and unripe Bananas.
- Few participants have incidents where they have eaten moldy food unknowingly.
- A participant's uncertainty about a dish's look or components may have contributed to their occasionally causes them to completely avoid trying new meals, which eventually restricted their culinary experiences and options.



Figure 9: Food appearance is affected because of colour blindness. Source: IndiaTV

4.2 Strategies adapted to overcome

Participants in the research were questioned about the methods they employed to get around the problems caused by their colour blindness. The results showed that depending on the circumstance, the majority of participants utilised a combination of several techniques. These are the strategies that participants have adapted knowingly or unknowingly to combat the above issues.

How do you typically approach food identification to minimize the impact of colour blindness? (Can choose multiple options)

7 responses

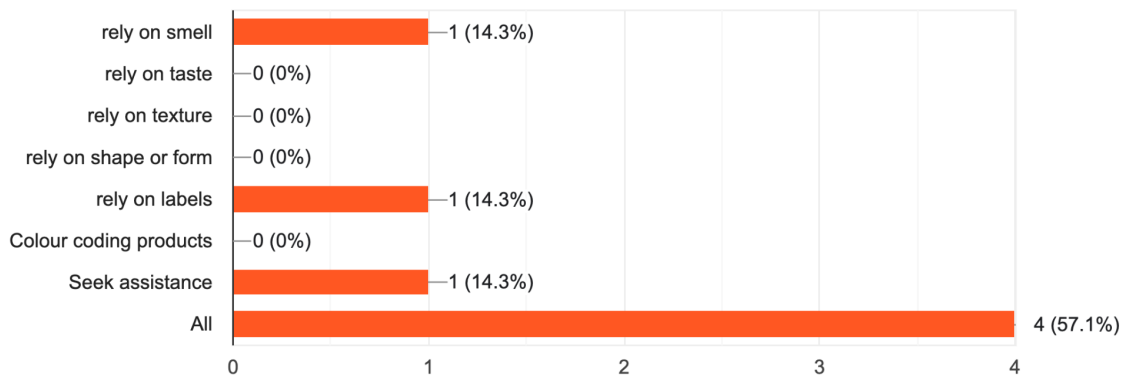


Figure 10: Approaches taken by the participants. Source: Survey done Link

Basis of texture, shape and size

Using other signals to determine the colour of food items was one of the participants' typical tactics. For instance, several individuals claimed to recognise food items based on their feel, shape, and size. Others claimed they could tell the colour of the meal by where it was on the dish or in the cooking vessel. Participants occasionally relied on the colour of the packaging or labelling to tell what items were within packaged goods.

Assistance

Asking friends or relatives for assistance was another tactic employed by participants. This was especially prevalent when buying or preparing meals. Participants said they frequently asked someone with normal colour vision to assist them in selecting or preparing food.

Some interviewees admitted to utilising smartphone applications created to aid colorblind people in distinguishing colours. These applications analyse an object's colour using the smartphone's camera and offer a written or voice explanation of the colour.

Own personal solutions

Several participants mentioned that they had over time created their own unique solutions that assisted them in overcoming the difficulties associated with colour blindness. For instance, several individuals claimed to have memorised the colour of specific foods or to have created their own method for arranging foods in the kitchen according to colour.

Colorblind people may still navigate the world of food despite their visual handicap by using alternate cues, asking for assistance, using technology, and adopting personal methods.

Table 1: List of Food items that raised issues for colour blind people. Problems faced and the strategies they adapted to combat the problems. Source of data: Online survey link. Source of images: Google-Freepik. Colour simulation done by: coblis.com




Activity	Food Item	Problem Faced	Strategy to overcome
Purchasing	Banana	Distinguishing Ripe and unripe bananas	Spots appearance
			
	Packaged Product	Buy wrong product when there is only colour difference	Ask someone
			
	Packaged Product	Can't tell Red and green label	Ask Someone
			

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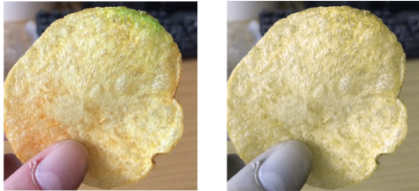

Activity	Food Item	Problem Faced	Strategy to overcome
	Orange & Lemons	Confusion between similar sized	Ask Someone
			
	Avocado	Can't figure if ripe or unripe	Squeeze test
			
	Vegetables	Can't tell when it is fresh	Ask someone
Cooking	Meat	Cooking meat	Ask Someone or using thermometer to check temperature
			
	Eggs	When eggs are cooked	Ask Someone
	Caramel	Can't verify if the color is correct shade of brown	Ask Someone or using thermometer to check temperature

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Activity	Food Item	Problem Faced	Strategy to overcome
	Turmeric & Chilli powder	Can't differentiate	Ask Someone
			
Eating	Banana	Ate unripe banana	Taste or look for the spots
	Potato Chips	Ate moldy chips	Ask someone
			
	Strawberry or blueberry flavour	Can't differentiate	Ask Someone
Any Dish	Don't feel like eating because of appearance	Avoid Eating	
			
New Dish	Hesitate to try out new dishes as they can't figure out the sauce, curries, etc.	Ask Someone if possible or avoid eating	

4.3 Insights

4.3.1 Packaging of food product

People who are colorblind may find it difficult to discern between various colours, making it tough for them to read and comprehend food packaging. Here are some ideas on how food packaging may be made to suit those who are colour blind:

- Use high contrast: People who are colour blind may find it simpler to read and comprehend the information on packaging if high contrast colours are used, such as black and white.
- Avoid using colour as the only way to transmit information, such as the flavour or kind of a food item: Avoid using colour as the only way to convey information. Use simple to comprehend symbols or detailed language instead.
- If colour is used on the container, utilise a variety of hues to make it easier for people who are colour blind to identify between the various components.
- Use texture and patterns: People who are colour blind may find it easier to distinguish between distinct package features, such as the brand name or logo, by using texture and patterns.
- Offering alternative packaging can assist people with visual impairments, such as colour blindness, in accessing crucial information about the food item. Examples of alternative packaging include braille or big print labels.

Food packaging may be made more accessible and user-friendly for those who are colour blind by including these design aspects. This may enhance their general food-related shopping and consumption experience.

4.3.2 Issues related to health

For those in particular occupations, colour blindness might be a problem. Here are some ideas about how to deal with these problems:

- Creating food labels with different colours can help people with colour blindness distinguish between safe and dangerous foods. For those with red-green colour blindness, who can have trouble telling some colours apart, this can be especially helpful.
- Giving audio instructions: People who are colour blind may find it useful to have audio instructions when cooking or preparing meals. This can contain audio directions for temperature settings, cooking durations, and other crucial details.
- Increasing illumination: People who are colour blind may benefit from adequate lighting, especially in places where food is being prepared. It is possible to guarantee that people can identify foods and colours correctly by improving lighting conditions.
- Training food handlers: Kitchen personnel and food handlers should get instruction on how to accommodate colour-blind people. This might involve instruction on how to properly label foods, convey vital information, and recognise and address any safety issues.
- Raising awareness and educating people about colour blindness and its effects on food safety can assist to guarantee that those who have colour blindness have access to safe and wholesome food alternatives. Informing people on safe food handling procedures and potential safety dangers are two examples of how to do this.

Healthcare experts and the food sector may develop methods to guarantee the health and safety of people who are colour blind by taking these findings into consideration. Additionally, educating and teaching colorblind people on food safety and quality standards can assist reduce any possible dangers in handling and preparing food. Their general well-being and quality of life may be enhanced by this.

4.3.3 Issues in professions of food industry

Imagine if you wanted to be a chef do you think colour blindness can create issues?
7 responses

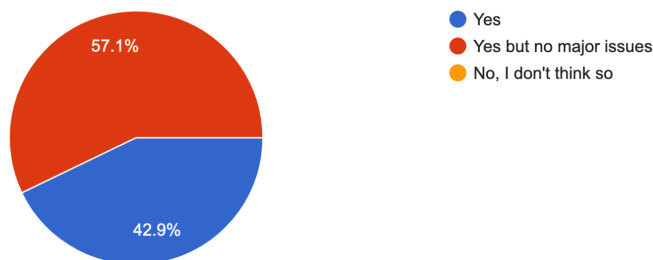


Figure 11: All participants think that colour blindness can create some issues for professionals like chefs. Source: Survey done Link

For people who are in charge of duties that involve colour recognition, such as food preparation, quality control, and product creation, colour blindness can present serious difficulties. Lack of colour vision can make it challenging to recognise colour-coded labels and discriminate between various food items colours, which can compromise the quality and safety of the meal.

- Colorblind people could find it challenging to distinguish between ripe and unripe fruits and vegetables or judge when the meat is cooked based on its colour, thereby posing a danger to food safety. When spices or sauces are added to a dish, colorblind people may find it difficult to notice colour changes in the components, which can lead to variations in flavour and quality.
- Colour Blindness can make it difficult to choose the ideal colour for food goods when developing products, such as packaging, branding, and marketing materials. A product's attractiveness and marketability may suffer as a result of colour selections made by colorblind people who may not be able to perceive the same colours as those with normal colour vision.

The food sector must thus address these issues by putting in place policies that take colorblind people's requirements into consideration. Last but not least, involving colorblind people in product development and marketing choices can help to guarantee that goods appeal to a variety of consumers, including those who have colour vision problems.

4.3.4 Application for colour blindness

There are many applications for colour blind people to help detect colours and see the colour simulation. These apps can help to detect colours of the food items, but they also have few limitations like

Photo lighting: The lighting of the photo may affect the colour detection.

Habit: Users don't have the habit of using apps before eating. Unless they are too sceptical about the food.

Inaccuracy: Apps that recognise colours automatically are not always reliable and may identify colours incorrectly, especially in complicated patterns or under certain lighting conditions.

Limited range: Some colour-detection applications might only be useful for specific colours or object kinds, and they might not be reliable for all sorts of food.

Technology dependence: Colour detecting applications call for the use of a smartphone or other electronic equipment, which may not always be practical or available.

Cost: Some colour recognition applications may charge a fee or demand a subscription, which may not be within everyone's means.

Learning curve: Using a colour detecting software might involve some practise and learning, which might not be practical for everyone.

5 Summary

The goal of the study was to learn more about the perceptions of colorblind people in connection to their dietary choices and approaches to food safety. Online questionnaires, virtual interviews, and online forum discussions were all used in the study. The sample was made up of people who had various forms of colour blindness, and In survey, demographic information was gathered to learn more about the participants' ages, genders, educational backgrounds, and occupations.

According to the study's findings, choosing, preparing, and consuming food might be extremely difficult for people who are colour blind. The participants reported having trouble distinguishing certain foods based on their hue, which restricted their eating options and raised their worry about food safety.

The participants also mentioned difficulties with food preparation, such as their failure to recognise colour changes in cooking meat, which raised worries about undercooking or overcooking food.

Despite these difficulties, the participants also shared a variety of coping mechanisms. These included relying on other senses, such as smell or texture to identify food, asking for help from others, and using technology, such as mobile apps made specifically for people who are colorblind.

The study also provided information about food product packaging and labelling, suggesting that more inclusive and accessible packaging could be advantageous for those who are colour blind. The study also emphasised the need for more education and knowledge of colour blindness in the food

business in order to enhance food safety procedures for everyone, including people who are colour blind.

The study highlights the need for greater accessibility and education in the food industry to better support people with colour blindness and offers significant insights into the difficulties faced by colour blind people when it comes to food selection, preparation, and consumption.

References

- Gouras, P. (2009, July 1). *Color Vision - Webvision - NCBI Bookshelf*. Color Vision - Webvision - NCBI Bookshelf. <https://www.ncbi.nlm.nih.gov/books/NBK11537/>
- Dobromir, R., Mihov, V., & Velizarova, R. (2020). The Influence of Color Vision Deficiency on Visual Perception in Food Decoration. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 68(1), 117–125. <https://doi.org/10.11118/actaun202068010117>
- Mollon, J. D. (1986). "Tho' She kneel'd in that place where they grew...": The uses and origins of primate colour vision. *Journal of Experimental Biology*, 124(1), 23-36.
- Nennstiel, A., Körner, M., Stamm, T. A., Wenzel, J., & Kühne, F. (2015). Colour vision deficiency and its impact on occupational safety. *Accident Analysis & Prevention*, 81, 55-60. <https://doi.org/10.1016/j.aap.2015.04.021>
- Palmer, S. E., Schloss, K. B., & Palmer, J. (2010). Color perception. *Wiley Interdisciplinary Reviews: Cognitive Science*, 1(6), 875-892. <https://doi.org/10.1002/wcs.95>
- Kalloniatis, M., & Luu, C. (2021). Color vision. In *Webvision: The Organization of the Retina and Visual System* (H. Kolb, E. Fernandez, & R. Nelson, Eds.). University of Utah Health Sciences Center. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK11515/>
- Brainard, D. H. (2003). Color vision. In *Encyclopedia of Cognitive Science* (L. Nadel, Ed.). Macmillan Publishers Ltd. <https://doi.org/10.1002/0470018860.s00119>
- Food - Colour Blind Awareness. (n.d.). Colour Blind Awareness. <https://www.colourblindawareness.org/colour-blindness/living-with-colour-vision-deficiency/food/>
- *Why can't color blind people see any colors?* (2013, July 2). Science Questions With Surprising Answers. <https://wtamu.edu/~cbaird/sq/2013/07/02/why-cant-color-blind-people-see-any-colors/>
- Burggraaff, O., Panchagnula, S., & Snik, F. (2021, April 19). *Citizen science with colour blindness: A case study on the Forel-Ule scale*. *Citizen Science With Colour Blindness: A Case Study on the Forel-Ule Scale* | PLOS ONE. <https://doi.org/10.1371/journal.pone.0249755>
- *Colorblind People Population! Statistics*. (2021, June 13). Colorblind People Population! Statistics. <https://www.colorblindguide.com/post/colorblind-people-population-live-counter>

- Links to Discussion: Reddit-
https://www.reddit.com/r/ColorBlind/comments/12pte1x/does_colour_blindness_restricts_you_from_trying/
- Facebook- Colour blindness and Colour Vision Deficiency Awareness:
<https://www.facebook.com/groups/449273171900640>