

# A Research on the General Knowledge of Pastry Chefs About Food Colorings and Their Awareness of Reading Labels

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## Abstract

Food colorings are substances commonly used to increase the desire to eat by making the appearance of the food more attractive. This study aims to determine the general knowledge of pastry chefs about food colorings and their perception of label reading awareness. For this purpose, field research and focus group interviews were used, and content analysis was applied to the research data. With the focus group interview data analysis, we determined the awareness of pastry chefs towards synthetic food colorings under two main headings (understanding the health effects of synthetic food colorings and food labels reading habit) and two sub-headings. We examined the food colorings used in many boutique pastry products, and, as a result, we observed that the food colorings that are common in the sector are synthetic. In addition, food colorings have been proven to cause behavioral disorders such as sleeping problems and hyperactivity in children, and some food coloring brands also state this information on their labels. As a result of our focus interviews with five pastry chefs who use synthetic food coloring directly in their workplaces, we observed that the knowledge on synthetic food coloring causes behavioral disorders in children is not very common among pastry chefs. We also determined that pastry chefs do not consider the health warnings on food coloring labels. In conclusion, the general knowledge of pastry chefs about food colorings and their awareness of label reading is insufficient.

**Keywords:** Food additives, Food coloring, Gastronomy, Hyperactivity, Pastry chefs.

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## 1. Introduction

People are sensitive to the color of the food they consume; it has been reported by Downham and Collins (2000) that appetite is almost directly related to the person's reaction to color, and this effect can be either positive or negative. The color perceived by the person gives clear information about the taste after consuming the food. Food colorants can be found in liquid, powder, or paste form in many different colors and are used in various pastry products. These colorants can be oil-based or water-based (Rinsky & Rinsky, 2008). The type of coloring to be used differs from product to product. For instance, since chocolate should not be mixed with water, an oil-based color should be chosen as appropriate food colorant (Wise, 2021). In the research by Myint and Kyu (2021), it was found that food colorings are used to make food look attractive, and it was added that they are divided into two categories: natural and synthetic. Natural food

colorings can be obtained from sources found in nature, such as plants (strawberries, blueberries, beets, red peppers, sweet potatoes, saffron, spinach, red cabbage, etc.) and insects (*Dactylopius coccus*, *Coccus lacca*, etc.). Humans have been adding colorants to foods for centuries. Besides, synthetic food colorings are widely used in bakery products, candy, ice-cream, cheese, jelly, jam, as well as, beverages consumed by sportsmen and sportswomen (Martins et al., 2016; Nowak, 2020).

The study conducted by Kobylewski and Jacobson in 2012 emphasizes that most of the tests regarding the safety of food colorings for human health are insufficient; in addition to the evidence on issues such as carcinogenicity, genotoxicity and, hypersensitivity, it has also been reported that these food colorants do not contribute to foods in terms of safety and nutritional value. For this reason, it has been advocated that food colorants used in the food products should be removed from the supply, and it is recommended to replace them with safer food colorants if they are to be used. It

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has been suggested that the authorities responsible for testing food coloring should be much more selective and careful and only well-tested and safe products should be approved (Gallo et al., 2020).

Since the 1970s, the use of synthetic food colorings has been linked with problems such as attention deficit and hyperactivity in children. When the observed behavioral disorders are examined, irritability, sleep disturbance, restlessness, and aggression come to the fore (Stevens, 2014). Researches by Myint and Kyu (2021), Ahmed et al. (2021), Corradini (2019), and Mittal (2020), reported that the consumption of synthetic food colorings has increased and that the largest consumer group is children. Moreover, these colorings cause health problems such as hyperactivity, cancer, and allergies in them. Another study conducted in hotel kitchens focused on the amount of colorant used in hotel kitchens for a better presentation, and also on increasing the use of natural colorants, and it was argued that children's menus should be composed accordingly. Thus, aiming to minimize the negative effects of food coloring on children, the goal is a child-friendly tourism (Hastaoğlu et al., 2018). In another article, it was mentioned that food is a necessity in human life, whereas food coloring is not. In addition, it has been mentioned that food colorings are used to add attractiveness to food, and it is emphasized that products containing food colorings can be chosen by consumers voluntarily. On the other hand, it has also been reported that consuming artificial food dyes is not harmful to health (Clemens & Pressman, 2018).

In this study, the perceptions of pastry chefs who use food coloring frequently and widely in their kitchens were evaluated, as well as the context in which they pay or do not pay attention to the content when purchasing food coloring.

## 2. The theoretical and conceptual framework

Food colorings are described by the Codex Alimentarius as “additives added to give color to food or to regulate the color of food” (McAvoy, 2014). Due to the differences in the chemical structures of many substances that have the property of coloring, they may have different chemical, physical, and physicochemical properties. For example, Sunset Yellow, which is a synthetic food dye, does not change its color as a result of its reaction with acids, and therefore it can be easily used in acidic foods (de Sá et al., 2013). Erythrosine is a red powder or granule and if the food is to be purple, it should be kept in the pH 7 and pH 10 range (Martins

et al., 2016). These features determine what kind of products they will be used for, for what purpose, and in what form (Greenhawt & Baldwin, 2008).

Food colorings are legally classified into two groups: certified and uncertified. All non-certified food colorings are obtained from natural sources. In the 1950s, after synthetic food colorings began to cause diseases in children in the USA, James Delaney began to hold hearings on synthetic food colorings in the US House of Representatives. Through the efforts of Delaney, in 1960, the FDA identified factors to consider when determining whether a color additive's recommended use is safe, as well as specific conditions for safe use that must be included in the listing regulation. As a result, such natural food colorings were removed from the list of certified color additives by the FDA in 1960 and included in the list of priority and continuous use (U.S. Food and Drug Administration, 2017). Certified food colorings are synthetically sourced and divided into colorings and pigments; colorings are soluble in water, pigments are not (Grumezescu & Holban, 2017).

### Natural food colorings

In the book by Delgado-Vargas (2002), “natural food coloring” is defined as the aroma and coloring component obtained from finely ground-dehydrated fruits. Natural food colorants are also defined as colors used in foods that are obtained from vegetables, fruits, various plants, and different microbiological sources. These colorants, which can be prepared at home, can also be purchased and used. Examples of natural colorants are shown in Table 1 (Hastaoğlu et al., 2018).

Table 1. Some of the natural coloring sources

Source of coloring	Color
Beetroot	Red or pink
Clover nettle	Green
Spinach	Green
Parsley	Green
Blackcurrant	Red/blue
Cherry	Red/blue
Red beet	Red/blue
Carrot	Yellow/orange
Orange	Yellow/orange
Saffron	Yellow/orange
Caramel	Brown

In another book by Rinsky and Rinsky (2008), the food colorings obtained from some different natural sources are as follows:

Yarrow: Yarrow is a plant of European origin that is widely grown in America, and its leaves are dried and used to sweeten tea. In addition, it is also known that

Table 2. Contents of some artificial food colorings in the patisseries

Brand	Code	Common name	Form of coloring	Color	Specifying the maximum amount to be used	Warning about effects on children
A	E 102	Tartrazin	Powder	Yellow	X	✓
B	E 102	Tartrazin	Liquid	Yellow	✓	✓
C	-	Ponceau 4R	Liquid	Red	✓	X
D	E 124	Ponceau 4R	Liquid	Red	✓	✓

food coloring is obtained from the flowers of the yarrow plant, which are yellow, pink, or magenta.

**Annatto:** Annatto is the seeds of the achiote plant from which food coloring is obtained. Yellow-red food coloring is obtained by dilution of these seeds in water and then cooking them in oil. An achiote plant is a small shrub plant that grows in tropical climates in America and Southeast Asia and is not consumed directly.

**Carmine:** This food coloring, obtained as a result of drying female cochineal insects, is used to give a deep red color to many products like candies, jellies, etc.

#### *Synthetic food colorings*

The effect of food colorants, which is very effective from the customer's point of view of the product and plays a major role in attractiveness, is a whole with freshness, taste, nutritional value, and incentive. When natural food colorings are examined based on the professional sector, they are reported as unstable and easily perishable. For these reasons, it is known that synthetic food colorings are widely used (Kucharska & Grabka, 2010). Synthetic food colorings are inorganic and synthetically produced food colorings are widely used in many desserts and pastries. The FDA should test the suitability of these food colorings for human consumption (Rinsky & Rinsky, 2008). In addition, the contents and codes of the permitted food colorings are reported in the list created by the European Parliament and Council Directive published in 1994 on synthetic food colorants (Directive, 1994).

In a study on blue food coloring, it has been stated that bright blue is commonly used in foods consumed by children, and therefore, synthetic food colorings cause concern. In this context, products in blue directly create the perception of being synthetic, and the existing belief in this subject is another issue that should not be ignored. As a result, the importance of turning to natural colorants is emphasized in the use of food coloring in various products (Spencer, 2018).

#### *The Labels of Food Colorings Commonly Used in Pastry*

In July 2010, the European Food Safety Authority made it obligatory to include the phrase “may have a negative impact on the activities and attention of

children “on the labels of foods containing synthetic colorings” (Kanarek, 2011). No similar information could be found in any official publication in Turkey. To obtain information within the scope of the research, the labels of food colorings of various brands and forms of colorants were examined in the markets that everyone and pastry makers could access. It was investigated whether the hyperactivity effect mentioned in the related articles was stated on the labels and whether food label contents were written descriptively. The information about the labels is as follows (Table 2).

#### *Pastry Chefs' Knowledge About Food Colorings and Label Reading Awareness*

Globalization and important developments in food science and technology are not properly understood by society, which often raises concerns among its members. There is a necessity to increase an awareness of reading food labels to eliminate health and food safety concerns. In terms of food safety and public health, food labeling can measure the reaction of both food producers and consumers to safety conditions of products. However, the subject of our study on understanding the knowledge of pastry chefs about food colorings and their awareness of reading food labels, has attracted the attention of very few researchers. Awareness of food label reading will enable pastry chefs to make informed decisions about food coloring choices (Danilola et al., 2019).

### **3. Method**

In this study, one of the qualitative research methods - focus group interviews, was applied., using the effect of group dynamics to obtain in-depth information and generate ideas through discussions between a small group and the leader (Adler et al., 2019). In this method, researchers can use focus groups to develop pre-existing knowledge about a known subject, or they can also use them to gain new ideas and information by focusing on the subject from another angle (Styśko-Kunkowska et al., 2018). Professional pastry chefs from Istanbul, who worked before as pastry chefs in various regions of Turkey, formed the main population of the research. The research sample was created using the

highest diversity method, and the participants were optimally selected. Thus, it was ensured that a homogeneous participants group was formed by considering their common characteristics regarding the research subject. In this way, it was ensured that the data obtained from the study would be more inclusive and useful in terms of content (Dilshad & Latif, 2013).

In the research, interviews were conducted using a semi-structured questionnaire to evaluate how consciously five pastry chefs use food colorings. The voluntary participants were asked to answer six questions on food colorings, and by evaluating their answers (with consent from the participant), the framework of the research was formed. The focus group interview questions were based on the research of Makeen et al. (2021) It was observed that the awareness of participants about negative effects of long-term use of food colorings on health was limited, and education on negative effects of synthetic food colorings on children was emphasized. Questions (designated as Q) have been revised based on the information obtained from researches (Rinsky and Rinsky, 2008; Kanarek, 2011; Stevens, 2014) for pastry chefs who use food colorings directly, and additional questions were also added to support the research. In addition, within the scope of the study, it was also sought to analyze whether the pastry chefs took information on food coloring labels into account. Therefore, the Q6 was added to the focus group interview. Also, demographic information about participants was also obtained. The questions addressed to the participants are as follows (Table 3).

In this study, the content analysis method was used to evaluate the focus group interviews data, as well as systematic analysis of a text based on making repeatable and valid inferences. To ensure the validity of the results, maximum attention was paid to obtaining the data objectively. For a study to be reliable, its reproducibility must be ensured, and the

same analysis must be done at different times and conditions. This means that another researcher obtains the same results under the same conditions. To ensure the reliability of the analysis results, the content of the interview was given to three different researchers and similar inferences were taken from them (Drisko et al., 2016).

A field study was conducted to find out the food colorings used in the boutique patisseries. Field research is a qualitative research method in which the researcher directly observes environmental conditions in the present (Feldman, 2019). The scope of the field research consisted of visits to five suppliers and five boutique patisseries.

#### 4. Results and Discussion

Field research has shown that synthetic food colorings are generally used in boutique pastries, and it has been observed that there are health warnings on the labels of some brands. It is thought that the main reason pastry chefs use synthetic food colorings instead of natural food colorings is that they cannot produce standard and attractive products with natural food colorings (Francis, 2002). Analysis of focus group interview data showed that pastry chefs' general knowledge of food dyes and their awareness of label reading was not sufficient. In addition, it was determined that the information that synthetic food colorings cause behavioral disorders in children was not known by the pastry chefs.

The analysis of the data from the focus group interviews demonstrates that the awareness of pastry chefs towards synthetic food colorings was gathered under two main headings and two sub-headings (Figure 1). The content analysis of the constructs and focus group interviews data, was evaluated in detail below.

Table 3. Focus group interview questions

No	Questions
Q1	Please write down in detail which food coloring products you use.
Q2	Do you know the names of the coloring substances found in some foods and beverages? Please write down the contents of food colorings in general, the source of these substances, and any other information about these colorings you may have.
Q3	It has been proven that coloring substances can cause some behavioral changes in children. Do you have any information about this and other adverse effects caused by artificial food colorants? Please explain.
Q4	Do you check the labels printed on food and beverages containing colorants before purchasing them? If so, please explain why you are doing this.
Q5	Would you buy or use coloring substances again if you knew they caused behavioral changes in children? In addition, what can you suggest as an alternative or solution to this situation?
Q6	Do you pay attention to the information on the labels of food colorings on the shelves? Is there any information that interests you in particular? Please explain briefly.

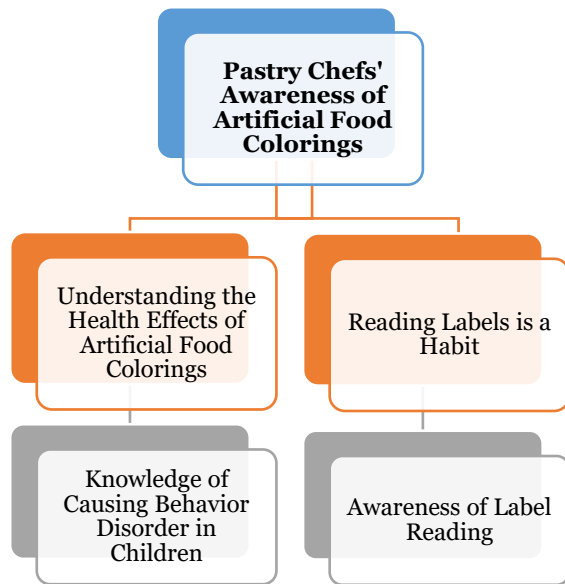


Figure 1. Constructs of pastry chefs' artificial food coloring awareness

Firstly, the demographic information of the focus group interview participants showed that the average age was 37, and all of them were females. All participants stated that they used food colorings at work. The questions answered in-depth by the participants revealed that the products in which food colorings were used in bakeries were sugar fondant, buttercream, royal icing, some cheesecake fillings and sauces (to give a more attractive appearance), chocolate, candy, macarons, marshmallows, writing on cakes and cookies, powder colorings to add dimension to sugar flowers, ice cream, batter of some sponge cakes (such as red velvet cake or rainbow cake), and meringues.

Considering the pastry chefs answers to Q2 about the content information of the colorings, it was observed that the names of the main colors (tartrazine, ponceau 4R, and brilliant blue) were prevail. In addition, all pastry chefs participating in the focus group interviews reported that they knew that those food colorants were not from natural sources and that they could be unhealthy.

According to participant 1, she was not aware of a food coloring agent causing any disorders in behavioral change in the children. In addition, she stated that synthetic food colorings are carcinogenic and unhealthy, but these negative effects can occur with the amount of use, as in many foods. She also added that on the labels of many food colorings, it is written the maximum amount to be used. According to participant 2, similar

to participant 1, she was not aware that food colorings could cause behavioral disorders in children, and added that when used excessively, they can be harmful to health and carcinogenic, as many packaged foods. According to participants 3 and 4, they were not aware of the effect of food colorings on children in this way, like the previous participants. In addition, they added that food colorings can be as unhealthy as any food with additives, and the level of consumption is important in this regard. Unlike the other participants, participant 5 reported that she usually followed the articles related to her job and that she read some articles about how food colorings can cause problems such as hyperactivity, sleep problems, and behavioral disorders in children. She also stated that she knew that these food colorings could have a cancer-triggering effect. She also stated like all other participants, that the use and consumption of food coloring is the determining factor for the negative effects on children's well-being and health in general.

When the participants were asked whether they check the labels printed on food and beverages containing colorants before purchasing, and if they do, for what purpose, the responses of the participants were as follows: Participant 1: "I look at the calories and sugar amount (when I want to eat healthy), I guess I don't pay much attention to whether there is coloring or not". Participant 2: "Yes, I always read the back of the packages because I eat naturally and healthily, I do not prefer colored ones". Participant 3: "Yes, I always check. I do my shopping according to the expiry date, whether there is a harmful oil (such as palm oil) or another additive in the ingredients". Participant 4: "Unfortunately, I don't, I know it actually needs to be looked at, but I'm not a very conscious consumer in this regard". Participant 5: "Yes, I checked the labels. I generally try to pay attention to whether it contains synthetics, its expiration date, and what is in it. I want myself and my family to consume foods with good content".

When the answers to Q5 were examined, the participants stated that they would not prefer to buy and use food colorants that cause behavioral disorders in children under normal conditions. However, they indicated that they have to continue on this path until well-pigmented natural food colorings come to the market, because food colorings, which are an important part of their business, have a significant difference with the colorants obtained from natural sources and the desired result cannot be obtained. Apart from the option to gain a strong position in the sector with the content and effects of natural food colorings, the changing

trends in the pastry sector were also highlighted by participants 1 and 4. While sugar fondant cakes were more common 5 years ago, nowadays cakes with cream on the outside area are in the foreground, which shows that the interest in sugar fondant has decreased. Over time, there is also the possibility that paints will be used less or not at all in the sector, depending on the demands of people. In addition to the thoughts of other participants, participant 5 answered Q5 in this way: *“I think that our customers are conscious consumers, and they make their children consume food-colored products consciously and in a controlled manner. The thing that draws attention on birthdays is that the sugar fondant of the cake is put aside. It is highly visual. Of course, some like the taste. We would revise our colorants in case there are naturally sourced colorings in the market that we can obtain the color tones we obtain for current food colorings.”*

In addition, participants with children added that they do not allow their children to consume food coloring either. Factors those participants pay attention to on the labels of food colorants are evaluated and the answers to Q6 are examined. The main points are as follows: compliance with food codex, expiry date, the maximum amounts allowed to be used, water or oil-based, non-toxic statement.

Food colorings are added to change colors lost during preparation or to make food look more appealing (World Health Organization, 2018). As mentioned in the article by Downham and Collins (2000), synthetic food colorants are used in a wide variety of products in the boutique pastry sector. However, studies funded by the Food Standards Agency (FSA) of some countries, such as the United Kingdom, have proven that children show behavioral disorders. For this reason, synthetic food colorings such as tartrazine, quinoline yellow, sunset yellow FCF, azorubine or carmoisine, ponceau 4R and allura red AC have been banned from use in foods since 2008. Today, many other synthetic food colorings are used in a wide variety of foods that tend to be brightly colored, including desserts, cakes, ice cream, and soft drinks (Bakthavachalu et al., 2020).

Apart from the products that clearly contain food coloring, it has also been determined that in some products (such as cheesecake filling and sauces), food coloring can be used without customers being informed, just to increase the appeal of the product, as Downham and Collins (2000), Myint and Kyu (2021), Clemens and Pressman (2018), Kucharska and Grabka (2010) pointed out in their articles. We think that manufacturers should inform customers about food colorings they use.

The issue of whether synthetic food colorings cause health problems, especially in children, has been discussed for many years (Shanmugasundaram & Rujaswini, 2019). In addition, with the increase in its use in the last decades, it continues to be of increasing concern to the public. The effect of synthetic food colorings on children's behavior has been studied for a long time, with various data obtained from research (Trasande et al., 2018).

According to the results of our study, pastry chefs who work in the field of boutique pastry are aware of the ingredients of the food colorings they use and are aware that they are not natural and may be unhealthy (for instance, they can be carcinogenic).

Except for one research-loving pastry chef, other pastry chefs do not have the knowledge that food coloring can cause behavioral disorders in children, although most of the food colorings are written on their labels. These pastry chefs, who have been in the food production sector for many years, are expected to approach additives more consciously.

As shared in the research by Kobylewski and Jacobson (2012), in areas where food colorants should be added into the food product, it is recommended to use colorings with safe content. The industry will continue to use these synthetic food colorings until natural ones are fully replaced by synthetic food colorings. It is also emphasized that the possibility of less or no use of these synthetic food colorings can be shaped by different trends emerging in the pastry field (such as the fact that only buttercream cakes are more popular than sugar fondant cakes).

Some businesses that produce low-cost pastry products ignore food safety rules and prefer synthetic dyes that are not suitable for food because they are cheap and give more color. For this reason, pastry chefs' knowledge of synthetic food dyes and their awareness of label reading becomes much more important for solving the problem. In this context, chefs need to read the food coloring label and know the E code on the product label. Contrary to the disinformation spread on social media about the E code, the E code is an international symbol given to food additives whose toxicological research has been completed and whose harmless dose has been determined (Martins et al., 2016). We think that important information about synthetic food dyes should be given to kitchen chefs by food scientists.

## 5. Conclusion

In conclusion, it has been determined that the general knowledge of pastry chefs about food colorings and their awareness of label reading are not sufficient. In this context, it has been observed that the knowledge that synthetic food colorings cause behavioral disorders in children is not known by pastry chefs. In addition, it was concluded that the information on the labels on the food colorings was not taken into account by the pastry chefs. It is foreseen that synthetic food colorings, which can have various negative effects on health, will never be used in the future, given the trend towards healthy products in pastry industry.

## Declaration of Competing Interest

The authors declare that they have no financial or non-financial competing interests.

## Author Contributions

M. Doğan (ORCID: 0000-0001-6391-4887): Definition, Conceptualization, Methodology, Validation, Investigation, Writing – Review & Editing, Supervision.

P. Olgay (ORCID: 0000-0003-1768-3613): Definition, Formal analysis, Investigation, Writing – Original Draft.

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