

**Research Article****TASTING THE RAINBOW: REVIEW ON COLORANTS, FLAVORINGS AND ADDITIVES USED IN SKITTLES*****Anisha Theres Cherian and *John Wyson**

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Received 11th February 2022; Accepted 18th March 2022; Published online 30th April 2022

Abstract

Skittles is a brand of fruit-flavored candy, currently produced and marketed by the Wrigley Company. With its vibrant colors, it is especially popular among children and teenagers. Skittles are small round chewy candies that come in many different colors in a bag. Skittles were originally called "Glees" and introduced and commercialized in Britain during the late 1960s. Candy's manufacture and distribution were limited to the United Kingdom till the mid-1970s. Americans were able to "taste the rainbow" for the first time in 1979. Skittles have a brief, colorless life before becoming the iconic version that everyone is familiar with. Coloring the candy can take anything from 4-6 hours. Each flavor from each Skittle comes from a secret flavoring process that occurs before they're lacquered. Skittles contain no animal-based products, according to a 2020 study. Ingredients such as Tapioca dextrin and modified corn starch are added to the candy to help preserve flavor and color. Skittles is the top-selling item, with \$329.9 million in sales, although that is slightly down compared to its preceding years. The brand is also partnering with GLAAD, the world's leading LGBTQ+ media advocacy group. Skittles will be the first Mars Wrigley brand to use compostable packaging in the United States.

Keywords: Fruit-flavored candy, Food colorants, Dextrin, Modified starch, Lacquering.**INTRODUCTION**

'Skittles' is the world's most popular non-chocolate candy. It is a brand of fruit-flavored candy, currently produced and marketed by the Wrigley Company, a division of Mars, Inc. These are small round chewy candies that come in many different colors in a bag. Skittles tag line has always been "Taste the rainbow", to signify the colorful aspect of the candy. With its vibrant colors, it is especially popular among children and teenagers. Initially, the candies came in a standard red packaging. However, in recent times the packaging has seen a wide array of colors after it launched different variants of the candies. The most recently introduced colors include Tropical, Sour Skittles, and Wild Berry. Skittles are marked with a letter "S" on them. The original colors were red for strawberry, orange for orange, yellow for lemon, purple for grape and green for lime although the flavor was changed to green apple in 2013.

History of skittles

Skittles were originally called "Glees" and introduced and commercialized in Britain during the late 1960s. Its manufacture and distribution were limited to the United Kingdom till the mid-1970s during which the company moved to North America, and Americans were able to "taste the rainbow" for the first time in 1979. While there is definite information regarding where the candies were first made, there is only scarce information regarding how they were made. The phrase "taste the rainbow" became in 1994 popular for advertising after the candy had various shades of colors and smell. Some suspect the distinct flavors of skittles may be influenced by the colors but Mars Wrigley Confectionery denies the claim. In 2016, the company launched limited-edition Skittles that were completely white in color.

The gesture was in support of the LGBT movement. To celebrate this occasion, the company started to produce these limited-edition candies in June every year. Apart from being an ally of the LGBTQ+ community, skittles have been vocal about other social issues.

Production

Each Skittles flavor is created in a unique way. That implies strawberry Skittles are very different from grape Skittles, green apple Skittles, and so forth. These flavors are brought to life by complete research and development teams. The hue has no bearing on the flavor. The specific flavor from each Skittle comes from a secret flavoring process that occurs before they're lacquered, not from its crazy-colored shell. Skittles have a brief, colorless life before becoming the iconic version that everyone is familiar with. Coloring the candy can take anything from 4-6 hours. The colorless, individual candies are known as "lentils." These colorless candies exist to ensure that each flavor really, truly stands up on its own. If you can taste a colorless Skittle and know in your heart and soul that it's lemon-flavored, the good people at Skittles have done their jobs. They're called lentils because they're shaped like them. These colorless lentils are taste tested first. Taste tests happen in a red, low-lit room with several pairs of lentils. After that, the lentils are coated. Each color coating is made one at a time. After they've all been created, the tastes are blended together on a blending belt, ensuring that each serving has a good grape-to-lemon-to-green apple-to-orange-to-ratio.

Ingredients used in the Skittles Original

- **Sugar:** Sugar cane stalks are used to make traditional white sugar, which is processed into smaller, whiter granules and utilized in Skittles. The sugar works as the base of the candy.
- **Corn syrup:** Also called glucose syrup, this syrup is made from corn starch and used to soften, add volume, improve

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taste, and acts as an interfering agent and stops the crystallization of sugar used in the candy, thus avoiding in grainy lentils.

Nutrition Facts	
Serving Size 1.4 oz (40g/about ¼ cup)	
Servings Per Container about 5	
Amount Per Serving	
Calories 160	Calories from fat 15
% Daily Value*	
Total Fat 1.5g	2%
Saturated Fat 1.5g	8%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 10mg	0%
Total Carbohydrate 37g	12%
Dietary Fiber 0g	0%
Sugars 30g	
Protein 0g	
Vitamin A 0%	Vitamin C 0%
Calcium 0%	Iron 0%
* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:	
	Calories: 2,000 2,500
Total Fat	Less than 65g 80g
Sat. Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2,400mg 2,400mg
Total Carbohydrate	300g 375g
Dietary Fiber	25g 30g
MADE OF: SUGAR, CORN SYRUP, HYDROGENATED PALM KERNEL OIL; LESS THAN 2% OF: CITRIC ACID, TAPIOCA DEXTRIN, MODIFIED CORN STARCH, NATURAL AND ARTIFICIAL FLAVORS, COLORS (RED 40 LAKE, TITANIUM DIOXIDE, RED 40, YELLOW 5 LAKE, YELLOW 5, YELLOW 6 LAKE, YELLOW 6, BLUE 2 LAKE, BLUE 1, BLUE 1 LAKE), SODIUM CITRATE, CARNAUBA WAX.	

Figure 1. Nutritional Facts on Skittles Original

- **Hydrogenated palm kernel oil:** This is a plant oil extracted from the kernel of the *Elaeisguineensis* oil palm. It's a flavor and texture enhancer in candy. The oil helps soften the candy and keep it from drying out. Hydrogenated palm kernel oil is also cost-effective.
- **Citric acid:** These are naturally found in citrus fruits and a manufactured version of citric acid is used in candy to increase acidity, improve flavor, and preserve ingredients. It is a colourless powder that is used with sugar to make "sour" candies and since Citric acid is a weak tricarboxylic organic acid. It is highly soluble in water and, once it dissolves in that, it shows weak acidity but a strongly acidic taste which affects sweetness and provides a fruity tartness commonly used to imitate lemon and lime flavours.
- **Tapioca dextrin:** This is a starch extract derived from the yucca plant or cassava root. It's used in Skittles as an adhesive candy coating and to help preserve flavor and color.
- **Modified corn starch:** Made from corn, this is an emulsifier and gelling agent that contributes to the gumminess of Skittles.
- **Natural and artificial flavors:** Details of these flavors are typically proprietary, but given Skittles' fruit-based flavors, it can be assumed they either come from natural fruit sources or are artificially made to mimic fruit flavors. Natural flavorings are usually made from plant or animal extracts. As of 2020 skittles original is a vegan product. There is very few or almost no data available regarding the flavoring used in skittles.

Table 1. Flavorings commonly used in candy

Flavor	Colour	Description
Strawberry	Red	Ethyl methylphenylglycidate is commonly used to give the distinctive strawberry flavor in candies.
Grape	Purple	American grapey flavor characterized by the Concord grape used to make our jams, jellies, and grape juices. That flavor is synthesized by the chemical methyl anthranilate (MANT).

- **Colors:** Skittles use Red 40 Lake, Red 40, Yellow 5 Lake, Yellow 5, Yellow 6 Lake, Yellow 6, Blue 2 Lake, Blue 1, Blue 1 Lake, and titanium dioxide. These are derived from raw materials obtained from petroleum. Skittles Original has about 33.3 mg per serving. Table 1 lists the colours commonly used to during skittles production.
- **Sodium citrate:** This is the sodium salt of citric acid, It is commonly known as sour salt and is mainly used as a food additive, usually for flavor (imparts tart flavor and is commonly called as sour salt) or as a preservative. Excess intake of sodium citrate may result in nausea, vomiting, diarrhea, and stomach pain.
- **Carnauba wax:** This is derived from the wax of the leaves of the palm plant *Coperniciaprunifera*. It's used in candy to keep coatings shiny and prevent them from melting. Carnauba wax is nontoxic and is Generally Recognized As Safe (GRAS) by the US Food and Drug Administration (FDA) as both a direct and indirect food additive.

Variation of skittles

Skittles have gone through various changes and modifications since it was first introduced in 1974, these include change in the original flavors and the limited edition series, the all time favorites being 'Wild Berry', 'Original' and the 'Sour' skittles. Table 2 lists the variations of the original produced by skittles from the 1970s till present.

Marketing

Skittles was brought into spotlight when for a second year they rereleased the limited edition packs featuring gray packaging and candies draw attention to the rainbow symbolizing the LGBTQ+ community. The brand is also partnering with GLAAD, the world's leading LGBTQ+ media advocacy group. During the month of June, \$1 per pack purchased will be donated to GLAAD, up to \$100,000. Limited-edition bags in 4-oz share-size and 15.6-oz resealable standup sizes are available for purchase. Pride Packs will have the original five fruity tastes of Strawberry, Orange, Grape, Green Apple, and Lemon, though without the normal colors on the package and candy. Skittles is also considered to have one of the smartest social media marketing strategies, being a fun, interactive presence on twitter and facebook thus attracting more people online.

Sales

According to IRI data in 2019, Skittles is the top-selling item, with \$329.9 million in sales, although that is slightly down compared to its preceding years, with about -0.7 percent change.

Table 3. List of skittles variations

Colors	Description
Red 40	Also known as Allura red AC(6-hydroxy-5-[(2-methoxy-5-methyl-4-sulfophenyl)azo]-2-naphthalenesulfonic) acid is a red azo(organic) dye. The red 40 dye is made synthetically from petroleum. These are preferred over straight colors due to their stability.
Red 40 lake	A lake is a solid, non-water soluble form of a dye. It's produced by mixing the dye with Aluminum Hydroxide. By itself Aluminum Hydroxide is a safe food ingredient and it's often sold as an antacid. When combined with Red Dye #40, the chemicals form a deep red powder that can be applied to the outsides of tablets, gumballs and other solids.
Yellow 5	Yellow 5, also known as Tartrazine (Trisodium (4E)-5-oxo-1-(4-sulfonatophenyl)-4-[(4-sulfonatophenyl)hydrazono]-3-pyrazolecarboxylate) is also an azo dye and has quite a few chemical similarities to Yellow 6 and Red 40 but this structure moves the reflected light to an even higher frequency than Yellow 6, producing a pure lemon-yellow color. This dye can also be mixed with Brilliant Blue FCF to produce green shades.
Yellow 6	Yellow 6(Disodium 6-hydroxy-5-[(4-sulfophenyl)azo]-2-naphthalenesulfonate)is a smaller molecule than Red40 and reflects light at a slightly higher frequency. While Red40 is described as a orangish-red color, Yellow 6 is described as a Yellowish-orange color. It's most often used to create a pure orange color in foods. Yellow 6 may be found in orange flavored foods.
Blue 2	Blue 2 is also called indigo blue or indigotine (Disodium [2(2'E)-3,3'-dioxo-1,1',3,3'-tetrahydro[2,2'-biindolydene]-5,5'-disulfonate). It is a synthetic version of indigo, a dye naturally produced from plants. It is an organic salt derived from indigo by aromatic sulfonation, which renders the compound soluble in water. It is approved for use as a food colorant in the U.S and E.U.
Blue 1	Popularly known as Brilliant Blue FCF , Blue 1 (disodium;2-[[4-[ethyl-(3-sulfonatophenyl)methyl]amino]phenyl]-[4-[ethyl-(3-sulfonatophenyl)methyl]azaniumylidene]cyclohexa-2,5-dien-1-ylidene]methyl]benzenesulfonate) is a synthetic organic compound used primarily as a blue colorant for processed foods, medications, dietary supplements, It has the appearance of a blue powder and is soluble in water and glycerol.
Titanium dioxide	Titanium white, Pigment White 6 (PW6), or CI 77891. Generally, it is sourced from ilmenite, rutile, and anatase. When used as a food coloring, it has E number E171. Titanium white is also used as an opacifier.

Table 2. Colors used to make the “lentil” coating

Name	Flavor	Year
Original Skittles	Grape (purple), Lemon (yellow) Green Apple (green), Orange (orange) Strawberry (red)	1974
Tropical (Rainforest)	Banana Berry (yellow) Kiwi Lime (green) Mango Tangelo (orange) Pineapple Passion fruit (blue) Strawberry Starfruit (pink)	1989
Wild berry	Berry Punch (violet) Melon Berry (green) Raspberry (blue) Strawberry (pink) Wild Cherry (red)	1989
Crazy Cores	Blue Raspberry Lemon Cherry Lemonade Mango-Peach Melon Berry Strawberry-Watermelon	2008-2011
Skittles Confused	The original flavors with the colours mixed up.	2008
Xtreme	Green Apple-Watermelon Red Apple (Watermelon-Green Apple) Grape-Lemon Lemon-Watermelon Lime (Lemon-Green Apple)	2009
Confused?	Similar to the earlier version but with different flavors, a green piece may be cherry in one bag, and peach in another. Blue Raspberry Cherry Lemon Mango + Peach Lime Watermelon Mandarin Blueberry Raspberry Melon Berry	2013
Sour	Sour Grape (purple) Sour Lime (green)* Sour Lemon (yellow) Sour Strawberry (red) Sour Orange (orange) Sour Green Apple (green)	2001
Crazy sours	Sour Apple (green) Sour Cherry Berry (purple) Sour Mandarin (orange) Sour Pineapple (yellow) Sour Raspberry (pink)	2003

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Smoothie mix	Lemon Berry (light yellow) Mixed Berry (pastel purple) Orange, Mango (faded orange) Peach Pear (light green) Strawberry Banana (light peach)	2013
Ice cream treats	Caramel Ripple (light brown) Chocolate (dark brown) Orange Strawberry (pink) Vanilla (beige) Vanilla Swirl (orange)	2010
Carnival	Bubble Gum (pink) Candy Apple (light yellow) Cotton Candy (baby blue) Liquorice (red) Green Slushy (green)	2010-2011
Skittles unlimited	Bubblegum (baby blue) Jam Doughnut (brown red) Popcorn (light yellow) Toffee Apple (green)	2011(limited)
Extreme fruit gum	Blue Raspberry (blue) Wild Cherry (red) Green Apple (green) Tangerine (orange) Watermelon (pink)	2006
Mint	Spearmint Wintergreen	2013
Chocolate	Hot Chocolate (white, later red) Milk Chocolate (brown) Mocha Chocolate (green) Nutty Chocolate (tan) Wild Chocolate (blue)	2008
Chocolate mix	Chocolate Caramel (brown) Brownie Batter (dark brown/black) Chocolate Pudding (auburn) S'mores (copper) Vanilla (off-white/buff)	2007
Skittes sensations	Chili Berry (red) Cool Raspberry (blue) Juicy Orange (orange) Lemon Tingle (yellow) Sour Apple (green)	2009
Skittles Fizzl'd Fruits	Berry Punch (violet) Melon Berry (green) Raspberry (blue) Strawberry (pink) Wild Cherry (red)	2010-2012
Skittles blenders	Strawberry Lime Blast (pink) Cherry Tropicolada (red) Green Apple Watermelon Freeze (green) Mango Lemonade Blast (peach) Melon Berry Blast (blue)	2011-2014
Skittles Riddles	Watermelon Cherry Punch Apple Raspberry	2012-2014
Skittles darkside	Wicked Pomegranate/Black Cherry (Red) Forbidden Fruit(Blue)/Sweet Strawberry (Purple) Midnight Lime (Green) Dark Berry(Purple)/ Dark Berry(Blue) Blood Orange (Orange)	Returns seasonally since 2015.
Skittles Desserts	Raspberry Sorbet (Red) Blueberry Tart (Blue) Key Lime Pie (Green) Orange Creme (Orange) Strawberry Milkshake (Pink)	2013-2016
Seattle Mix Skittles	Raspberry (Blue) Melon Berry (Green)	2014(limited)
Skittles Orchards	Red Apple (light red) Cherry (dark red) Lime (green) Peach (peach) Orange (orange)	2014-2017

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Flavor Mash-Ups!	Banana Berry (yellow) Kiwi Lime (green) Mango Tangelo (orange) Pineapple Passion fruit (blue) Strawberry Starfruit (pink) Berry Punch (violet) Melon Berry (green) Raspberry (blue) Strawberry (pink) Wild Cherry (red)	2015
Skittles brightside	Paradise Punch (Blue) Kiwi Banana (Yellow) Tangerine (Orange) Watermelon (Green) Pink Lemonade (Pink)	2017
Skittles Pride Fruits (all white edition)	Strawberry Orange Blackcurrant Lemon Lime	Exclusive during the pride month since 2017
Skittles Holiday Mix	Grape (Green) Green Apple (Light Green) Strawberry (Dark Red) Wild Cherry (Red) Lemon (Light Green)	Christmas edition (2015-)
Zombie Skittles	Petrifying Citrus Punch (Orange) Mummified Melon (Green) Boogeyman Blackberry (Blue) Chilling Black Cherry (Purple) Blood Red Berry (Red) Rotten Zombie (Random color)	Halloween edition (2019-)
Skittles Chewies	Orange Lemon Blackcurrant Strawberry Lime	2018

Currently, the candy brand is produced by the Wrigley Company, a subsidiary of Mars, Incorporated. The Wrigley Company was purchased by Mars in 2008 for 23 billion dollars and as of September 2021, the Mars Wrigley is a \$40 billion (sales) company.

Innovations

Mars Wrigley (the parent company) has formed a two-year agreement with Danimer Scientific, a developer and maker of biodegradable materials, to develop home compostable packaging. Mars Wrigley will use its worldwide treat and snack portfolio to encourage consumers to compost at home, collaborating with customers and supply-chain partners to support a healthy world.

"The impact of plastic on nature is one of the major sustainability challenges of our generation. There are no simple solutions and transformational innovation is necessary, we have to think and act differently," said Alastair Child, Mars Wrigley v.p. of global sustainability.

Skittles will be the first Mars Wrigley brand to use compostable packaging in the United States.

Conclusion

The "Skittles Effect" is a "morale-boosting effect that makes the soldier feel good [when they see a recognizable product in their rations] because they feel like they're not so far from home." D'Andrea Bros., LLC v. U.S., 109 Fed. Cl. 243, 258 (Fed. Cl. 2013).

Testimony in a real court case.

Skittles is loved by sweet toothed adults and children alike. Although incredibly unhealthy for frequent intake because of the amount of sugar (73.7g per 100g) and the a large amount of hydrogenated vegetable oil per pack, Skittles will always be preferred because of the fun and bright colours and flavors and the playfulness it brings and is now an authentic part of pop culture with its influence growing though celebrities, athletes and social media influencers. Infact, skittles are so popular that skittles 'smoothies', 'popcorns', 'ice creams', 'pancakes' and 'waffles' are all on the rise along with many other facinating yet odd creations. The hard shells and their chewy centers are iconic despites the numerous dupes available in the market. According to a survey conducted during 2016, skittles was voted America's favourite non-chocolate candy according to Neilson Holdings, an American information, data and market measurement firm.

REFERENCES

1. Nutritional Facts| <https://www.reference.com/world-view/dyes-skittles-6ecf54541d06bbdataable> packaging in the United States.
2. Linda Blackford, Your brain on Skittles| <https://physiology.med.uky.edu/news/your-brain-skittles>
3. THE SCIENCE BEHIND FOOD FLAVOURINGS| <https://www.chemoxy.com/about-2/knowledge-hub/the-science-behind-food-flavourings/>
4. The Best Skittles Flavors| <https://www.ranker.com/list/skittles-flavors/ranker-food>
5. Skittles| <https://www.snackhistory.com/skittles/>
6. Sodium CITRATE| <https://www.webmd.com/drugs/2/drug-3023/sodium-citrate-citric-acid-oral/details>
7. Sales of the leading non-chocolate chewy candy brands of the United States in 2017| <https://www.statista.com/>

- statistics/190409/top-non-chocolate-chewy-candy-brands-in-the-united-states/
8. This Is America's New Favorite Candy| <https://fortune.com/2016/06/20/skittles-americas-favorite-candy/>
 9. The Untold Truth Of Skittles| <https://www.mashed.com/199356/the-untold-truth-of-skittles/>
 10. Why the "Purple" Flavor is Different in the US and the UK| <https://dannwoellertthefoodetymologist.wordpress.com/2020/07/13/why-the-purple-flavor-is-different-in-the-us-and-the-uk/>
 11. Skittles: A Rainbow of Social Media Marketing| <https://www.destinationcrm.com/Articles/CRM-Insights/Insight/Skittles-A-Rainbow-of-Social-Media-Marketing-53694.aspx>
 12. <https://www.bestproducts.com/lifestyle/a33278775/skittles-smoothies-candy/>
 13. Famous fans taste the rainbow| <https://www.icf.com/next/case-studies/skittles-influencer-engagement/>
 14. Mars Wrigley to introduce compostable packaging for U.S. Skittles brand| <https://www.candyindustry.com/articles/89616-mars-wrigley-to-introduce-compostable-packaging-for-us-skittles-brand>.
