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The Rise of Synthetic Colors in the American Food Industry, 1870–1940

This article examines how, starting in the 1870s, food manufacturers in the United States began to use standardized color, achieved by synthetic dyes, as part of their marketing strategies. The emergence of the synthetic dye industry paralleled the growth of mass production and mass marketing in the American food industry. It provided food manufacturers with an economical means to standardize their products and helped establish brand identities through consistent appearance. By 1938, food dyes had achieved such widespread use, and had raised such public concern, that the federal government amended the 1906 Pure Food and Drug Act to implement more stringent measures to regulate the industry.

Beginning in the late nineteenth century, food manufacturers devoted enormous resources to determine and create the "right" color of foods, which many consumers would recognize and in time take for granted. Color was easier to control, reproduce, and commoditize than other sensory factors. The smell of foods, for instance, was difficult to convey in print or other media. In contrast, color served as a powerful communication tool. Food manufacturers began using color as a signal of consistent quality that would be visually appealing to consumers in the market transaction. As a result, standardized color became a key component in the rise of mass production and mass marketing in the food industry.

The expansion of standardized coloring took place within a broader context well known to business historians. In the 1870s and 1880s, the development of transportation and communication infrastructure, the rise of managerial business enterprise, and innovations in manufacturing machinery and processes lowered the cost of mass-producing and mass-marketing standardized products.[1] Within this emergent era of

[1] Richard S. Tedlow, *New and Improved: The Story of Mass Marketing in America* (Boston, 1996). See also Alfred D. Chandler Jr., *The Visible Hand: The Managerial Revolution*

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large-scale production and marketing, characterized by low margins, low prices, and national mass distribution, standardized food color became a competitive advantage for pioneering firms using synthetic dyes, particularly the dairy and confectionery industries. In the 1870s, dye manufacturers, including Wells, Richardson & Company, and the Christopher Hansen's Laboratory Company, began supplying synthetic food colors to dairy producers for coloring butter and cheese. By the 1930s, with the growth of the food dye industry, food manufacturers had been coloring various products, including butter, margarine, cheese, sausages, pasta, canned foods, ice cream, jellies, and candies. Uniform coloration thus became a norm in the food industry. As the use of food dyes expanded, American consumers had their standardized colors, but with them came real or perceived health risks. As a result, the safety of dyes, as well as uniformity, became a source of advantage for food manufacturers.

Although the food coloring practice was widespread elsewhere, the United States became a leading country in the food coloring business with the rise of extensive mass marketing.[2] By the late 1970s, the country had become by far the largest consumer of food dyes: in 1977, the American consumption of synthetic food dyes amounted to 2,300 tons, followed by the entire Western European region where 1,050 tons were consumed.[3] By 2015, the global food dye market had grown to roughly $1.5 billion.[4]

By examining the commercial significance of standardized color in the food industry, this article brings a new dimension to the existing historical literature on marketing and consumer capitalism. It is well-established in business history studies how intensive advertising, branding, and product choice became major characteristics in the mass marketing of consumer goods from the 1870s to the 1920s.[5] To establish

in American Business (Cambridge, Mass., 1977); Geoffrey Jones and Nicholas J. Morgan, eds., *Adding Value: Brands and Marketing in Food and Drink* (New York, 1994); and Richard S. Tedlow and Geoffrey Jones, eds., *The Rise and Fall of Mass Marketing* (New York, 1993).

[2] Peter J. Atkins, Peter Lummel, and Derek J. Oddy, eds., *Food and the City in Europe since 1800* (Hampshire, U.K., 2007); Adam Burrows, "Palette of Our Palates: A Brief History of Food Coloring and Its Regulation," *Comprehensive Reviews in Food Science and Food Safety* 8, no. 4 (2009): 394–408; John Walford, ed., *Developments in Food Colours*, vol. 1 (New York, 1984).

[3] John Walford, "Historical Development of Food Coloration," in Walford, *Developments*, 22.

[4] Brett M. Hundley, Paul Betz, and Omar J. Mejias, "Sensient Technologies Corporation," 30 Mar. 2015, BB&T Capital Markets Initiating Coverage Report, accessed at Thomson One, https://www.thomsonone.com/Workspace/Main.aspx?View=Action%3dOpen&BrandName=www.thomsonone.com&IsSsoLogin=True.

[5] Roland Marchand, *Advertising the American Dream: Making Way for Modernity, 1920–1940* (Berkeley, 1985); Pamela Walker Laird, *Advertising Progress: American Business and the Rise of Consumer Marketing* (Baltimore, 1998); Jackson Lears, *Fables of Abundance:*

a strong national brand and successfully market products, manufacturers not only promoted their names and products but also needed to supply products that would optimize brand value.[6] It is hence necessary to look holistically across the range of corporate activities to fully understand the marketing process. For example, Robert Fitzgerald suggested that the British chocolate manufacturer Rowntree became a pioneer in marketing not only because of effective branding and advertising, but also because of the firm's manufacturing practice, corporate culture, and industrial relations.[7] By analyzing how manufacturers created and marketed food with uniform color, this article also links corporate marketing with manufacturing processes, government regulation, and broader trends in consumption.

The use of dyes has been discussed tangentially in a number of literatures. Historians of the chemical industry have explored the development of synthetic dyes in Europe and the United States. Few studies, however, have fully examined the history of the food dye business or the interindustrial relations between the dye and food industries.[8] The limited historical studies about food coloring have mainly focused on food additives in the context of the early-twentieth-century pure food movement and regulation.[9] In his doctoral dissertation of three decades ago, historian Sheldon Hochheiser examined the federal government's regulatory policies on food coloring from the enactment of the 1906 federal Pure Food and Drug Act to the 1960 amendment.[10]

While building on Hochheiser's work, this article analyzes food-coloring regulation as a standardization activity that occurred at the intersection between the dye industry and the federal government. Government regulation specified standards for safe dyes, and helped

A Cultural History of Advertising in America (New York, 1994); Susan Strasser, *Satisfaction Guaranteed: The Making of the American Mass Market* (New York, 1989).

[6] Douglas B. Holt, "Brands and Branding," Harvard Business School case 9–503–045, revised 11 Mar. 2003 (Boston, 2002).

[7] Robert Fitzgerald, *Rowntree and the Marketing Revolution, 1862–1969* (Cambridge, U.K., 2007).

[8] John J. Beer, *The Emergence of the German Dye Industry* (Urbana, Ill., 1959); L. F. Haber, *The Chemical Industry, 1900–1930: International Growth and Technological Change* (New York, 1971); Kathryn Steen, *The American Synthetic Organic Chemical Industry: War and Politics, 1910–1930* (Chapel Hill, 2014); Anthony S. Travis, *Dyes Made in America, 1915–1980: The Calco Chemical Company, American Cyanamid and the Raritan River* (Jerusalem, 2004); Anthony S. Travis, *The Rainbow Makers: The Origins of the Synthetic Dyestuffs Industry in Western Europe* (Bethlehem, Pa., 1993).

[9] Oscar E. Anderson, *The Health of the Nation: Harvey W. Wiley and the Fight for Pure Food* (Chicago, 1958); Lorine Swainston Goodwin, *The Pure Food, Drink and Drug Crusaders, 1879–1914* (Jefferson, N.C., 1999); James Harvey Young, *Pure Food: Securing the Federal Food and Drugs Act of 1906* (Princeton, N.J., 1989).

[10] Sheldon Hochheiser, "Synthetic Food Colors in the United States: A History under Regulation" (PhD diss., University of Wisconsin–Madison, 1984).

standardize the color of foods on the market.[11] Government policies on food safety stimulated the integration of color manipulation into food businesses by regulating, and endorsing, the industry's color control practices. Dye manufacturers, particularly H. Kohnstamm & Company and the Schoellkopf, Hartford & Hanna Company, in turn made "strategic use of public policy" by stressing the importance of complying with a food law and by actively participating in the establishment and implementation of food dye standards.[12]

Historians of consumer culture have shown how an increasing number of firms began in the early twentieth century to capitalize on color for various commodities, including clothes and automobiles.[13] For these products, color variety became a crucial element of brand identity and consumer choices. The color of foods cannot, however, be understood solely as an indicator of abundant varieties. The calibration of color was essential for food manufacturers to designate flavor, prevent the discoloration of foods, and make foods look natural and fresh.

Standardization when pursued in variant lines of business, such as foods and automobiles, posed different challenges and had different consequences. As Steven Usselman has shown, for example, the increasing level of product standardization and innovations in railroad engineering enhanced the efficiency, safety, and comfort of railroad transportation.[14] In the food industry, color standardization meant asserting the idea of naturalness, such as green canned peas or yellow butter, even as manufacturers imposed a "natural" color through artificial dyes. In the 1920s and 1930s, many food advertisements and marketing rhetoric presented an image of "perfect naturalness" as the subordination of nature to technology. Uniformity represented one of the technological triumphs over

[11] For a discussion on regulation as standards, see Nils Brunsson and Bengt Jacobsson, *A World of Standards* (New York, 2000); Andrew Russell, "Standardization in History: A Review Essay with an Eye to the Future," in *The Standards Edge: Future Generations*, ed. Sherrie Bolin (Ann Arbor, 2005), 3; and Samuel Krislov, *How Nations Choose Product Standards and Standards Change Nations* (Pittsburgh, 1997), 54–60.

[12] Donna J. Wood, *Strategic Uses of Public Policy: Business and Government in the Progressive Era* (Boston, 1986).

[13] See Regina Lee Blaszczyk, *The Color Revolution* (Cambridge, Mass., 2012); Charlene Elliott, "Taste™: Interrogating Food, Law, and Color," *Senses and Society* 7, no. 3 (2012): 276–88; William Leach, *Land of Desire: Merchants, Power, and the Rise of a New American Culture* (New York, 1993), 9, 39–70, 323–48; and Marchand, *Advertising the American Dream*, 120–27.

[14] Steven W. Usselman, *Regulating Railroad Innovation: Business, Technology, and Politics in America, 1840–1920* (New York, 2002). See also Ken Alder, *The Measure of All Things: The Seven-Year Odyssey and Hidden Error That Transformed the World* (New York, 2002); David F. Noble, *America by Design: Science, Technology, and the Rise of Corporate Capitalism* (New York, 1977); and Douglas J. Puffert, *Tracks across Continents, Paths through History: The Economic Dynamics of Standardization in Railway Gauge* (Chicago, 2009).

nature.[15] Producers' desires to create sustained profits and streamline production constructed the standardized "natural" color of foods at a nexus of chemical engineering, government regulation, and industrial capitalism.

The Development of the Food Coloring Business

Food coloring has been a common practice across cultures for millennia, at least since ancient Egyptians used saffron to color various foods. Before the introduction of synthetic dyes in the late nineteenth century, so-called natural dyes derived from plants and organic minerals, including saffron, indigo, and cochineal (red dye extracted from insects), had been the major source of coloring foods in many parts of the world. The use of these dyes was limited as they were expensive. Saffron had been an important global commodity since ancient times, literally worth more than its weight in gold.[16] Cochineal had been very popular for textile and art painting as well as for food coloring among European aristocrats and upper-class consumers since the Spanish conquest of Central America in the sixteenth century.[17] In the late 1850s, cochineal was traded for about $1.50 to $2.00 per pound ($45.00 to $59.00 in 2015 U.S. dollars) in the United States.[18]

Synthetic dyes afforded food manufacturers new ways of coloring foods that were economical, consistent, and convenient, allowing for a new level of control and standardization. In 1856, British chemist William Henry Perkin succeeded in processing the first synthetic dye, mauve.[19] Following his invention, a number of chemical companies began expanding the palette of synthetic colors. As historian Warren Susman noted, "chemically produced colors made possible a world of color never seen before."[20] Synthetic dyes were generally more stable

[15] Lears, *Fables of Abundance*, 171, 174. On the relationships between nature and technology, see William Cronon, ed., *Uncommon Ground: Toward Reinventing Nature* (New York, 1995); Susan R. Schrepfer and Philip Scranton, eds., *Industrializing Organisms: Introducing Evolutionary History* (New York, 2004); and Richard White, "From Wilderness to Hybrid Landscapes: The Cultural Turn in Environmental History," *The Historian* 66, no. 3 (2004): 557–64.

[16] Maguelonne Toussaint-Samat, *A History of Food*, trans. Anthea Bell (Cambridge, Mass., 1992), 518–19; Pat Willard, *Secrets of Saffron: The Vagabond Life of the World's Most Seductive Spice* (Boston, 2001).

[17] Amy Butler Greenfield, *A Perfect Red: Empire, Espionage, and the Quest for the Color of Desire* (New York, 2005); Elena Phipps, *Cochineal Red: The Art History of a Color* (New Haven, 2010).

[18] "Commercial and Financial," *Daily Alta California*, 4 July 1858.

[19] Simon Garfield, *Mauve: How One Man Invented a Color that Changed the World* (New York, 2000).

[20] Warren Susman, *Culture as History: The Transformation of American Society in the Twentieth Century* (Washington, D.C., 2003), xxv.

and stronger in their coloring properties than natural dyes. Due to their intensity, the amount required to sufficiently color food was much less than that of natural colors; hence, synthetic dyes were more economical. Moreover, while the color of natural dyes faded when exposed to direct sunlight, synthetic dyes were less vulnerable to light.[21]

The versatility of synthetic dyes enabled dye and food manufacturers to mass-produce uniform products consistently and economically. Dye makers could manufacture and sell the same dye for a variety of products. Food processors, too, benefited from mass-produced, inexpensive synthetic dyes as they could create various hues for different products by changing the amount of dye added to foods and by mixing several colors. For instance, the synthetic color Brilliant Blue FCF added bluish, sometimes greenish, hues to canned peas, ice cream, cake icing, and soft drinks.[22] Food manufacturers used the green color of canned peas to help consumers visualize naturalness and freshness, while green and bluish shades of ice cream and icing indicated flavor and aesthetic variations.

The early manufacturing of synthetic food dyes was part of the development of the chemical industry in the late nineteenth century. H. Kohnstamm & Company of New York City and the Schoellkopf, Hartford & Hanna Company of Buffalo, New York, both founded by German immigrants in the 1840s, were the pioneers of food dye manufacturing. Germany was the global leader in the dye industry from the 1870s to the 1910s, accounting for almost 90 percent of the global dye production.[23] H. Kohnstamm and Schoellkpf imported dye materials from Germany and refined them for the American food industry. By the early 1910s, Schoellkpf had become the leading dye manufacturer in the United States, with a 50 percent share of the market, including both food and nonfood dyes.[24]

[21] Otto F. Hunziker, *The Butter Industry: Prepared for the Use of Creameries, Dairy Students and Pure Food Departments* (LaGrange, Ill., 1920).

[22] National Aniline & Chemical Company, *"National" Certified Food Colors: Certified to the Bureau of Chemistry, Department of Agriculture* (New York, 1922); "New Blue Food Dye Approved," *Food Industries* 1, no. 12 (1929): 570.

[23] Steen, *The American Synthetic*, 19, 23; Mira Wilkins, "German Chemical Firms in the United States from the Late Nineteenth Century to the Post–World War II Period," in *The German Chemical Industry in the Twentieth Century: Chemists and Chemistry*, ed. John E. Lesch (Norwell, Mass., 2000), 285–322.

[24] H. Kohnstamm & Company, "The Development of Certified Pure Food Colors," in *Chemical Industry's Contribution to the Nation: 1635–1935*, ed. Williams Haynes and Edward L. Gordy (New York, 1935), 5–16; Michael Brian Powers, "The Early Industrial Achievements of the Schoellkopf Family" (MA thesis, Niagara University, 1979); Benjamin Schwantes and Juliane Hornung, "Jacob Frederick Schoellkopf," Immigrant Entrepreneurship: German–American Business Biographies, German Historical Institute, 6 Jan. 2014, http://www.immigrantentrepreneurship.org/entry.php?rec=188.

The introduction of synthetic food dyes paralleled innovations in processed food products. Until the last decades of the nineteenth century, commercially processed foods had not been widely available, except for a few items, such as bread and butter. Most Americans relied on food products supplied by local farmers and produce they grew themselves.[25] In the early 1830s, the typical grocery list of an American family consisted largely of bread, meat, butter, potatoes, sugar, milk, and tea.[26] The production and consumption of processed foods increased rapidly between the 1870s and 1920s. By 1900, manufactured food accounted for almost a third of the value of all finished commodities produced in the United States.[27] While processed foods comprised about 20 percent of food items traded by a grocer in the early 1870s, more than half of food products in a 1915 grocer's catalog were processed.[28] By 1920, virtually all households purchased some form of commercially processed foodstuffs, including margarine, canned foods, and candies.[29]

As processed foods were more likely than agricultural products to be colored with synthetic dyes, Americans consumed ever-increasing amounts of those dyes in their everyday diets. During food processing, the color of the finished products changed due to heat and other handling: canned green peas looked dark green and sausages turned brown. It was hence necessary for manufacturers to add dyes to these processed foods to make them consistently look appetizing. In 1895, for example, more than 80 percent of dyes used for coloring margarine in Ohio were synthetic dyes.[30] The Jell-O Company had replaced vegetable colors with synthetic dyes for coloring its popular gelatin dessert by the early 1930s.[31] For many manufacturers, synthetic dyes became one of the crucial ingredients in making foods look enticing and uniform during the first decades of the twentieth century.

The dairy industry was one of the earliest to recognize the economic benefits of using synthetic dyes in the food industry. The coloring of

[25] Harvey Levenstein, *Revolution at the Table: The Transformation of the American Diet* (Berkeley, 2003), 30; Waverley Root and Richard de Rochemont, *Eating in America: A History* (New York, 1976), 129–33, 150–55; Susan Strasser, *Never Done: A History of American Housework* (New York, 1982), 11–12, 16–17.

[26] Root and Rochemont, *Eating in America*, 133.

[27] Nancy F. Koehn, "Henry Heinz and Brand Creation in the Late Nineteenth Century: Making Markets for Processed Food," *Business History Review* 73, no. 3 (1999): 350.

[28] Wm. F. Comply & Company, *Catalogue of Stock of Fresh Groceries* (Philadelphia, 1874); Eldridge, Baker Company, "Wholesale Grocery Catalog" (1915), box 6, "Food," Warshaw Collection of Business Americana, circa 1724–1977, Archives Center, National Museum of American History, Washington, D.C.

[29] Koehn, "Henry Heinz and Brand Creation," 350.

[30] Agricultural Commission of Ohio, Annual Report (Columbus, Ohio, 1895), 179–92.

[31] Rosemarie D. Bria, "How Jell-O Molds Society and How Society Molds Jell-O: A Case Study of an American Food Industry Creation" (PhD diss., Columbia University, 1991), 40–43.

butter had long been a widespread practice in Europe where dairy farmers had colored butter already in the fourteenth century, as well as in the United States at least since the eighteenth century.[32] The shade of butter fluctuated seasonally from bright yellow in summer to pale white in winter, depending on the kind of cattle feed, the breed of cows, and the period of lactation. Dairy farmers colored butter with carrot juice and extracts of plant seeds, called annatto, to give them a uniform yellow all year round.[33]

In the late 1870s, dye makers Wells, Richardson & Company and the Christopher Hansen's Laboratory Company introduced their first synthetic dyes for "butter colors," prepared specifically for coloring butter.[34] The chemical firm Heller & Merz Company also developed synthetic dyes, Yellow AB and Yellow OB, for coloring butter and other foods, including cheese and margarine.[35] These synthetic dyes were oil-soluble, so that they easily imparted color into fat. Commercially produced butter colors enabled dairy producers to dye butter by simply adding coloring solutions from a container purchased at a nearby supply house, without going through the time consuming processes of extracting vegetable juices. The cost of coloring butter decreased significantly. In 1907, the cost of vegetable butter colors was about $2.00 ($50.00 in 2015 U.S. dollars) per gallon, while synthetic dyes cost about $1.60 to $1.70 ($40.00 to $45.00 in 2015 U.S. dollars). The amount of vegetable colors required to impart satisfactory color to butter was about two to three times more than the amount required of synthetic dyes.[36]

These packaged solutions also helped standardize the color of butter. When individual farmers made their own coloring solutions from various ingredients, the shades of dyes and of butter differed significantly among producers. In fact, uniformity of color was one of the qualities that butter color makers stressed to their customers. In its 1905 advertisement, Wells, Richardson claimed that its color "never varies—

[32] In 1396 Paris, legislatures passed a law that banned the coloring of butter. Margaret Visser, *Much Depends on Dinner: The Extraordinary History and Mythology, Allure and Obsessions, Perils and Taboos of an Ordinary Meal* (New York, 1987), 89.

[33] Hunziker, *The Butter Industry*; Xerxes A. Willard, *Willard's Practical Butter Book: A Complete Treatise* (New York, 1875).

[34] Burlington Board of Trade, *Burlington, Vt. as a Manufacturing, Business and Commercial Center, with Brief Sketches of its History, Attractions, Leading Industries, and Institutions* (Burlington, Vt., 1890); "History," Christopher Hansen Laboratory Company, accessed 21 Sept. 2015, http://www.chr-hansen.com/about-us/history; Charles H. Possons, *Burlington in Brief* (Glens Falls, N.Y., 1890).

[35] Sheldon Hochheiser, "The Evolution of U.S. Food Color Standards 1913–1919," *Agricultural History* 55, no. 4 (1981): 385–91.

[36] E. H. Farrington, "A Comparison of Aniline and Anatto Butter Colors in Butter Making," *University of Wisconsin Agricultural Experiment Station Bulletin* 152 (June 1907), 6, 9.

it never fades."[37] By the early 1900s, synthetic butter colors had displaced annatto and other vegetable dyes almost entirely.[38]

Dairy-industry leaders and dye manufacturers contended that because butter had always been dyed with yellow colors and consumers assumed it was always yellow, the coloring of butter was a necessary practice to make butter "look like butter" at all times of year.[39] Dairy associations regularly published articles in trade journals and farm newspapers to warn farmers not to "overlook the color" especially during winter.[40] Claiming that color was one of the few factors in butter making over which producers had absolute control, industry leaders often complained that farmers guessed the amount of dyes put into the churn. Such "carelessness" did not achieve uniformity in the finished product.[41] Dye makers touted the economic benefit of their products by stressing that color was an essential factor that determined the grade and commercial value of butter. "Better butter color means bigger butter profits"—in a 1916 advertisement, Wells, Richardson stressed the higher profitability of the "rich golden hue" of butter dyed with its product.[42] With such phrases, butter color makers stressed that only a few cents invested in their products would bring dollars to the pockets of dairy farmers.

The confectionery industry was another pioneer in using synthetic colors and the largest consumer of dyes in the food industry. An economic benefit was one of the primary reasons that many confectioners turned to synthetic colors since only "a few grains" of those dyes could "color hundreds of pounds of candy."[43] Inexpensive so-called penny candies became increasingly available in the latter half of the nineteenth century due to the mechanization of candy manufacturing and the decline in the price of sugar. By the early 1870s, penny candies had become ubiquitous, available in candy shops, corner stores, five-and-dime stores, and newsstands.[44] Confectioners quickly adopted synthetic dyes to maximize their profits.

[37] Wells, Richardson & Company Advertisement, *Elgin Dairy Report*, 27 Feb. 1905, 1.

[38] "Abolishing Coal Tar Colors," *Dairy and Produce Review* 4, no. 3 (1903), 2; "Butter Color Poison," *Farm, Field, and Fireside*, 10 Feb. 1906.

[39] "Color in Butter," *Dairy Record* 8, no. 9 (1907): 7.

[40] "Don't Overlook the Color," *Dairy Record* 11, no. 11 (1910): 2.

[41] James Sorenson, "Practical Butter Making," *Dairy Record* 15, no. 27 (1913): 27. See also "Advised to Color Butter," *Farm, Field, and Fireside*, 26 July 1902; "Butter-Making on the Farm," *Prairie Farmer*, 16 June 1900; "Color Butter Higher," *Dairy and Produce Review* 5, no. 25 (1903): 2; and "Don't Forget the Color," *Dairy Record* 11, no. 28 (1910): 8.

[42] Wells, Richardson Advertisement, *Chicago Dairy Produce* 23, no. 2 (1916): 17.

[43] "National Confectioners' Association Convention," *Confectioners' and Bakers' Gazette* 26, no. 287 (1905): 19.

[44] Wendy Woloson, "Candy and Candy Bars," in *Oxford Encyclopedia of Food and Drink in America*, vol. 1, ed. Andrew F. Smith, (New York, 2007), 90; Samira Kawash, *Candy: A Century of Panic and Pleasure* (New York, 2013), 30–37.

Synthetic dyes also provided confectioners with color varieties and uniform shades, allowing them to designate various flavors. Dye manufacturers promoted to confectioners the use of their coloring products by distributing recipe booklets and production manuals. These recipes usually included formulas for making certain shades by mixing dyes.[45] A mixture of Tartrazine (yellow dye) and Orange I by a ratio of 85 to 15 became "egg yellow"; Tartrazine and Guinea Green B, by a ratio of 97 to 3, made a "lime green" shade.[46] Coloring formulas and instructions helped confectioners make a specific shade the "natural" color of certain flavors and foods, such as eggs and limes, although the actual food often did not look like the color created by synthetic dyes. The use of food coloring and the arbitrary associations between color and flavor allowed confectioners to standardize the color of their products.

While candy and dessert makers used dyes mainly to represent flavors and give rainbow colors to their products, other manufacturers added colors to make foods look "natural" and "fresh." Meat packers used color additives to give a red and pink color to cured meat products, including bacon, sausages, and hams.[47] A 1905 meat-packing manual advised butchers to mix red dyes with sausage stuffing or soak casing in color solution to give the finished product "a heavy, smoked appearance" and a "wholesome" look.[48] A chemical manufacturer in Chicago, B. Heller & Company, advertised various preservatives and dyes for coloring sausages and hams in its 1901 meat-packing manual: the company's dye "makes a NATURAL, BRIGHT, FRESH MEAT COLOR" (emphasis in the original).[49] These industry manuals suggested that the artificial coloring was an indispensable means for producers to create the finished product's "natural" appearance.

As the economic advantage of synthetic dyes became widely recognized in the food industry, agricultural producers also employed them to manipulate a physical property of produce, as though the color of fruits and vegetables was a malleable, external characteristic of the food. During the early 1930s, Florida citrus growers began to color orange skins by soaking the fruit in synthetic color solutions, to make the fruit look ripe. Certain varieties grown in the state ripened without a change in skin color, due to the warm climate. Growers strongly believed that oranges with green skins would not sell on the national

[45] See B. Heller & Company, *Heller's Guide of Ice-Cream Makers* (Chicago, 1927); and Warner-Jenkinson Manufacturing Company, *Ice Cream, Carbonated Bever*ages (St. Louis, 1924).

[46] "Basic Formula for Blending Colors," *Food Industries* 11, no. 1 (1939): 55.

[47] McArthur, Wirth & Company, *Butchers' and Packers' Tools and Machinery* (Syracuse, N.Y., 1900), 74–76.

[48] F. W. Wilder, *The Modern Packing House* (Chicago, 1905), 356.

[49] B. Heller Advertisement in McArthur Wirth, *Butchers' and Packers' Tools*, 78.

market even if the fruit was ripe inside.[50] By the 1940s, the so-called color-add process had been widely adopted in Florida. During the 1946–1947 season, twenty-one million out of thirty million boxes of fresh oranges shipped out of state were colored with synthetic dyes.[51] Food producers used synthetic dyes also for coloring such perishable items as fresh meat, salmon, and sweet potatoes.[52]

Synthetic-Dye Regulation and Standards

As the use of chemical substances, both toxic and harmless, increased rapidly in the early twentieth century, government officials, journalists, home economists, and social reformers harbored a suspicion about the safety of synthetic dyes. Until the turn of the century, there had been no federal or state regulation of food coloring practices. Without effective regulatory systems, more than eighty additives used for coloring foods were on the American market, and some of them were toxic.[53] Some producers used poisonous metals and chemicals. Chalk was used to whiten bread; lead and copper were added to canned foods to preserve color; and lead chromate was used to give milk a yellowish, creamy shade.[54] Newspapers reported a number of incidents in which brightly colored candies caused illness and sometimes death in children.[55]

The passage of the federal Food and Drug Act of 1906—the first national legislation against food adulteration—brought the use of coloring in food products under government supervision and resulted in a thorough investigation. The act prohibited the coloring of foods (without labeling) to conceal damage or inferiority and the addition of

[50] Sheldon Hochheiser, "May We Dye Our Oranges: Technological Innovation Breeds Political Controversy in the Florida Citrus Industry, 1933–1937," in *History and Sociology of Technology: Proceedings of the Twenty-Fourth Annual Meeting of the Society for the History of Technology* (Milwaukee, Wisc., 1982), 304–9; L. P. Kirkland, "The 'Color Added' Situation," *Proceedings of the Florida State Horticultural Society* 49 (1936): 103–6.

[51] *Problems of the Citrus-Fruit Industry: Hearings on S. Res., Day 1, Before a Subcomm. of the Comm. on Agriculture and Forestry*, 80th Cong. 28 (1948).

[52] "Artificially Colored Salmon," *American Food Journal* 13, no. 6 (1918): 319; Bernhard C. Hesse, "Coal Tar Colors Used in Food Products," Bulletin No. 147, Bureau of Chemistry, USDA (1912), 24.

[53] Hesse, "Coal Tar Colors," 11, 20–21.

[54] Burrows, "Palette of Our Palates," 396; David Denison Stewart, "A Clinical Analysis of Sixty-Four Cases of Poisoning by Lead Chromate, Used as a Cake-Dye," *Medical News* 51, no. 27 (1887): 753–58. Lead chromate was a highly poisonous chemical compound with a vivid yellow color, usually used in paints.

[55] See "Adulterated Confectionery: The Poisonous Compounds That Are Sold in Cheap Shops for Candy," *New York Times* (hereafter *NYT*), 8 Dec. 1877; "Things Not Always What They Seem: Adulterated Goods That Have Been Sold to an Unsuspecting Public," *NYT*, 27 Dec. 1895; "Boy Killed by Candy," *Confectioners Journal* 32, no. 372 (1906): 70; "Girl Is Dead," *Confectioners Journal* 32, no. 378 (1906): 89; and "Mother and Children Poisoned by Candy," *Confectioners Journal* 32, no. 375 (1906): 70.

poisonous substances to confectionery.[56] A few months after the passage of the 1906 act, the USDA's Bureau of Chemistry (the predecessor of the Food and Drug Administration) began conducting investigations on color additives to determine which dyes were safe for use in food.

The regulation and chemical analysis of food color embodied a new understanding of foods that was becoming common in Europe and in the United States at the turn of the twentieth century. After research in nutrient science took off in mid-nineteenth-century Europe, scientists began to analyze every single constituent part of food. As foods were increasingly understood based on their nutrient content, the perception of food in science, business, and politics was transformed fundamentally by what historian Uwe Spiekermann calls a "nutrient paradigm."[57] Based on research in food science and technology, food manufacturers created new products by isolating and recombining various nutrients and raw materials. Government officials believed that control of nutritive contents and other ingredients, including color additives, was the most effective way of regulating fraud in food production and sale.[58] As synthetic dyes became the subject of government regulation and scientific research, regulators, scientists, and manufacturers understood color as a food component that could be analyzed, transformed, and isolated from the product.

In establishing food coloring regulatory policies and dye standards, USDA officials relied on scientists from the chemical industry.[59] Bureau of Chemistry chief Harvey Wiley appointed chemist Bernhard Hesse as an outside consultant for the bureau's New York laboratory since there was no in-house expert on food dyes. Before working for the government agency, Hesse had worked as a research chemist for Badische Anilin und Soda Fabrick (BASF), one of the largest German chemical companies, from 1896 to 1906. He served as an important bridge between the federal government and the dye industry until he left his Bureau of Chemistry job in December 1915, to work as a research consultant for the General Chemical Company in New York City.[60]

[56] Federal Food and Drugs Act of 1906, Pub. L. 59–384, §34, Stat 768 (1906).

[57] Uwe Spiekermann, "Redefining Food: The Standardization of Products and Production in Europe and the United States, 1880–1914," *History and Technology* 27, no. 1 (2011): 11–36.

[58] Ibid., 13–14.

[59] Political scientist Nolan McCarty argues that as industry and scientific knowledge became complicated and professionalized, regulators came to rely on industry expertise in ways that tilt decision making toward industry interests. Nolan McCarty, "Complexity, Capacity, and Capture," in *Preventing Regulatory Capture: Special Interest Influence and How to Limit It*, ed. Daniel Carpenter and David A. Moss (New York, 2014), 99–123. See also Edward J. Balleisen and David A. Moss, ed., *Government and Markets: Toward a New Theory of Regulation* (New York, 2010); and Thomas K. McCraw, "Regulation in America: A Review Article," *Business History Review* 49, no. 2 (1975): 159–83.

[60] "Bernhard C. Hesse," *Oil, Paint and Drug Reporter* 91, no. 7 (1917): 7; F. B. Linton to Enterprise Chemical Company, 17 Feb. 1919, box 55, entry 1001, Records of the Food and

As Hochheiser argued, legislators and government scientists served not only to regulate food-coloring practices but also to expand the food-dye business by endorsing the use of certain synthetic dyes as harmless.[61] In June 1907, the USDA issued Food Inspection Decision 76, which certified seven synthetic dyes as safe for food use, based on Hesse's investigations.[62] Hesse had selected the seven colors not only because he considered them harmless but also because they were "most heavily used" by the dye and food industries. Since these dyes included "yellow, orange, blue, green, red, bluish scarlet, and brilliant cherry red," food manufacturers could create virtually any hue by mixing them.[63] None of the seven certified colors was patented, and thus their manufacture was open to any producer competent to make them.[64] Until the early 1920s, however, only two American dye companies—H. Kohnstamm & Company and the Schoellkopf, Hartford & Hanna Company—were involved in certified-dye manufacturing. Some dye makers did not see the certified-dye business as profitable.[65] Others were not able to manufacture high-quality certifiable dyes.

The quality standard for dyes was based primarily on their purity. Because most synthetic dyes were produced from by-products of coal processing, they contained substances such as poisonous metallic salts, sulfated ash, and arsenic derived from coal tar. During the distilling and purifying processes, these impurities were removed from the dye mixture.[66] The Bureau of Chemistry's purity standard for dye certification was so high that many dye makers could not meet the requirement. The bureau had rejected one of the first samples submitted by Schoellkopf, because it contained 0.09 percent of impure substances; the bureau's purity standard was 0.05 percent.[67]

The United States was a latecomer in food coloring regulation. In England, the Sale of Food and Drugs Act of 1875 banned mixing injurious

Drug Administration, RG 88, National Archives, College Park, Md. (hereafter NACP); Carl L. Alsberg to Harmon Color Works, Inc., 13 Mar. 1919, box 55, entry 1001, RG 88, NACP.

[61] Hochheiser, "Synthetic Food Colors."

[62] USDA, Office of the Secretary, Food Inspection Decision (hereafter FID) 76, "Dyes Chemicals and Preservatives in Foods," 13 July 1907. The seven dyes were amaranth, Ponceau 3R, erythrosin, Orange I, Naphthol Yellow S, Light Green SF Yellowish, and indigo disulfoacid.

[63] Hesse, "Coal Tar Colors," 28.

[64] Ibid., 13.

[65] Bernhard Hesse to Harvey Wiley, 21 Mar. 1908, box 160, entry 8, Records of the Bureau of Agricultural and Industrial Chemistry, RG 97, NACP.

[66] Irving W. Fay, *The Chemistry of the Coal-Tar Dyes*, 2nd ed. (New York, 1919).

[67] Hesse to Wiley, 8 Dec. 1908, box 160, entry 8, RG 97, NACP. See also Hesse to Wiley, 23 Nov. 1908, box 160, and Hesse to Wiley, 1 Dec. 1909, box 321, both in entry 8, RG 97, NACP.

ingredients, including colors, with food.[68] Germany's 1887 Color Act prohibited the use of food colors detrimental to health.[69] Other nations, including Austria, France, Italy, and Switzerland, also passed legislation against the use of poisonous colorings for foods in the late nineteenth century. These European enactments were, however, not consistent or effective because new synthetic colors appeared constantly on the market and processes of chemical analysis were not standardized; there was thus confusion among legislatures and chemists as to which dyes should be prohibited.[70]

Nor was the American legislation fully effective. Contrary to Hesse's proposition, the USDA did not require the use of certified food dyes. It was lawful to use uncertified dyes as long as the addition of coloring matter was marked on labels and the colors used for confectionery were not proved to be injurious to health.[71] Antimonopoly and laissez-faire ideals in Progressive-era political culture hindered the USDA from establishing more stringent means of regulating food colors. Government officials believed that if the use of certified dyes was mandated, there would be a monopoly in the certified-dye business since only two manufacturers supplied certified colors.[72] Believing that the government would eventually require the use of certified colors, dye companies began experimenting with the seven certified dyes. But sales of the certified colors disappointed H. Kohnstamm and Schoellkopf. They complained to Hesse that the business in certified colors was "very slack" and that food and dye makers would not use them "unless some pressure [was] brought to bear."[73]

H. Kohnstamm and Schoellkopf carried out marketing campaigns to promote the use of certified dyes, asserting that government certification would serve as a marker of food quality and safety. "The advertising advantage to those using Certified Colors can readily be seen," H. Kohnstamm noted in its advertisement, featured in the trade

[68] F. L. Dunlap, "The Food Laws of the United Kingdom and Their Administration," Bulletin No. 148, Bureau of Chemistry, USDA (1911); C. L. Hinton, *Food Additive Control in the United Kingdom* (Rome, 1960); Derek J. Oddy, "Food Quality in London and the Rise of the Public Analyst, 1870–1939," in Atkins, Lummel, and Oddy, *Food and the City*, 91–103.

[69] Volker Hamann, *Food Additive Control in the Federal Republic of Germany* (Rome, 1963); Vera Hierholzer, "The 'War Against Food Adulteration': Municipal Food Monitoring and Citizen Self-Help Associations in German, 1870s–1880s," in Atkins, Lummel, and Oddy, *Food and the City*, 117–28.

[70] Hesse, "Coal Tar Colors," 35–40; Hugo Lieber, *Use of Coal Tar Colors in Food Products* (New York, 1904), 12–32.

[71] Hesse to Wiley, 2 Dec. 1909, box 321, entry 8, RG 97, NACP; Hochheiser, "Synthetic Food Colors," 50.

[72] Hesse to Wiley, 28 Feb. 1908, box 321, and Hesse to Wiley, 21 Mar. 1908, box 160, and Hesse to Wiley, 19 July 1909, box 321, all in entry 8, RG 97, NACP.

[73] Hesse to Wiley, 19 Oct. 1909, box 321, entry 8, RG 97, NACP. See also Hesse to Wiley, 2 Dec. 1909, and Hesse to Wiley, 16 Dec. 1909, both in box 321, entry 8, RG 97, NACP.

magazine *American Food Journal*.[74] The confectionery industry was one of the first industries that H. Kohnstamm approached as a major outlet for its certified colors. The firm published advertisements in confectionery trade journals to inform candy makers as to the newly established certification system, and stressed the safety of its products.[75] In 1910, the Bureau of Chemistry also announced to food manufacturers that the federal government strongly recommended certified dyes for coloring foods. Although the bureau still did not mandate the use of certified colors, it suggested that the use of uncertified dyes risked violating the law.[76] While uncertified dyes remained on the market, the promotion of certified colors both by the dye makers and by government officials gradually led food manufacturers to discard uncertified colors in favor of certified dyes. By the early 1910s, H. Kohnstamm and Schoellkopf were receiving orders regularly from food manufacturers.[77]

After the outbreak of World War I, food-dye research became institutionalized. As Britain tightened the blockade during the war, American dye companies could no longer import sufficient dye materials from Germany. The development of a strong domestic dye industry became an urgent necessity for the industry as well as for the federal government.[78] In 1916, Congress appropriated $50,000 to establish the Color Laboratory within the Bureau of Chemistry, to investigate and regulate dyes produced and used in the United States. One of the primary objectives in establishing the Color Laboratory was to assist and cooperate with American chemical companies "in every way possible" by "avoiding any direct competition with the commercial laboratories."[79] The Color Laboratory certified food dyes and provided government control and supervision over dye manufacturing.[80] To support the chemical industry in dye investigations and production, the laboratory compiled American

[74] H. Kohnstamm Advertisement, *American Food Journal* 4, no. 2 (1909): 31. See also "Certified Colors," *American Food Journal* 4, no. 12 (1909): 18; "Certified Colors Now on the Market," *American Food Journal* 4, no. 2 (1909): 24; and H. Kohnstamm, "The Development," 32.

[75] See H. Kohnstamm Advertisement, *Confectioners' and Bakers' Gazette* 29, no. 315 (1907): 111.

[76] USDA, Office of the Secretary, FID 117, "The Use of Certified Colors," 3 May 1910.

[77] Hochheiser, "Synthetic Food Colors," 52–53.

[78] "Analysis of the Coal-Tar Dye Industry," *Journal of Industrial and Engineering Chemistry* (hereafter *JIEC*) 6, no. 12 (1914): 972; Bernhard C. Hesse, "The Industry of the Coal-Tar Dyes: An Outline Sketch," *JIEC* 6, no. 12 (1914): 1013–27; O. P. Hopkins, "Effect of the War on American Chemical Trade," *JIEC* 10, no. 9 (1918): 692–700.

[79] "The Color Laboratory," Color and Farm Waste Division Report (1926), box 1, entry 62, RG 97, NACP.

[80] Gibbs to Alsberg, 8 Jan. 1916, box 2, Color Lab Special File (hereafter CLSF), entry 2, RG 97, NACP. See also Joseph A. Ambler, "The Work of the Color Laboratory," *JIEC* 15, no. 9 (1923): 970; and H. D. Gibbs, "The Color Laboratory of the Bureau of Chemistry: A Brief History of Its Objects and Problems," *JIEC* 10, no. 10 (1918): 802.

dye patents and loaned manuscript copies to industry. The laboratory's chemists also undertook the manufacture of commercial dye products that were not produced by American dye companies due to a lack of technological or financial resources.[81] The Color Laboratory centralized research on food dyes and functioned as a government agency that helped develop, as well as oversee, the American food dye industry.

The government regulation and certification system helped create and expand a new market for the certified-dye business. In 1925, Color Laboratory chemist C. E. Senseman (whose name suited his job perfectly) reported that the production of synthetic dyes certified by the laboratory had doubled in three years: from 333,330 pounds in 1922 to 639,000 pounds in 1925.[82] By the mid-1920s, the number of certified dye manufacturers had increased to five companies, including H. Kohnstamm and the National Aniline & Chemical Company (the successor of Schoellkopf).[83] In observing the expansion of food coloring businesses, a Color Laboratory scientist stated that the kinds of food colored with synthetic dyes were so numerous that "hardly a person in this country could pass a day without swallowing dyes unsuspectingly in such foodstuffs as butter, cheese, cake, candy, ice cream, [and] soft drinks."[84] As various hues of less-expensive synthetic dyes became available, with government endorsement, manufacturers increasingly capitalized on the color malleability of food by making it look natural, fresh, and appetizing.

The Creation of the New Food Market

The American food coloring business grew rapidly due to the extensive marketing in the food industry, as well as the establishment of the certified-dye market. The United States was the largest and fastest growing market in the world from the late nineteenth to the early twentieth century.[85] The establishment of large chain stores and self-service supermarkets also expanded substantially. By the 1930s, A&P, then the largest American chain store, had operated more than 15,000

[81] H. T. Herrick, "The Contribution of the Color Laboratory to Industry," *JIEC* 18, no. 2 (1926): 1334.

[82] C. E. Senseman, "Summary of Certification of Food Colors Fiscal Year Ending June 30, 1925," box 5, CLSF, entry 2, RG 97, NACP.

[83] The five manufacturers were Warner-Jenkinson Company, Dyestuffs & Chemicals, Inc., Bates Chemical Company, H. Kohnstamm, and National Aniline. C. E. Senseman, "Report of Progress, Color Laboratory, April 1 to June 30, 1925," box 5, CLSF, entry 2, RG 97, NACP.

[84] Joseph A. Ambler, "Coal Tar Dyes We Eat and Drink," *American Food Journal* 18, no. 2 (1923): 87.

[85] Chandler, *Visible Hand*.

stores nationally.[86] In many European nations, it was not until after World War II that self-service supermarket merchandising expanded.[87] The use of synthetic chemicals for foods had been prevalent in Europe since the nineteenth century. Yet the mass production and mass marketing of foods and the modern retailing system in the United States facilitated the standardization of food color on a much larger scale than other countries.

Industrially manufactured dyes made possible not only economies of scale but also ever-increasing varieties in color. The development of economical synthetic dyes was vital to the ability of manufacturers to produce various goods, creating color-saturated mass culture at the turn of the twentieth century. Color "was pouring into all facets of modern life"—advertisements, street signs, textiles, art, and foods.[88] In contemplating the implication of standardization, Henry Ford contended in 1931 that standardization "introduced unheard-of variety into our life" rather than "making for sameness." "Machine production," continued Ford, "diversified our life, [and gave] a wider choice of articles than was ever before thought possible."[89] His statement, seemingly contradictory as Ford manufactured only black cars, points to all the variety that entered American life after standardization. Standardization led to experiments with colors and styles, while allowing manufacturers to reduce production costs; consumers were thus able to buy more goods. A growing variety of foods with bright uniform colors in food stores and households became a significant part of modern culture that many Americans encountered at the turn of the twentieth century.

Dye makers promoted to food manufacturers the powerful impact of color on food consumption—both purchasing and eating while emphasizing the economic benefits and safety of chemically synthesized colors. They emphasized that their colors could give foods an appetizing look with bright, attractive hues. In 1921, National Aniline proclaimed in its company brochure—distributed at the National Exhibition of Chemical Industries—that "color and tints in foods" had "definite appeal to the eye and to the palate" and that "an attractive table, rich in color," was the "first aid to a healthy digestion." Stressing its leading role in the

[86] Tedlow, *New and Improved*, 195.

[87] Peter Lummel, "Born-in-the-City: The Supermarket in Germany," in Atkins, Lummel, and Oddy, *Food and the City*, 169; Leigh Sparks, "The Rise and Fall of Mass Marketing? Food Retailing in Great Britain since 1960," in Tedlow and Jones, *The Rise and Fall*, 59.

[88] Joshua Yumibe, *Moving Color: Early Film, Mass Culture, Modernism* (New Brunswick, N.J., 2012), 17.

[89] Quoted in Thomas McCraw and Richard Tedlow, "Henry Ford, Alfred Sloan, and the Three Phases of Marketing," in *Creating Modern Capitalism: How Entrepreneurs, Companies, and Countries Triumphed in Three Industrial Revolutions*, ed. Thomas K. McCraw (Cambridge, Mass., 1995), 273.

development of food colors certified by the Bureau of Chemistry, National Aniline argued that the firm's synthetic dyes were indispensable to the creation of eye-appealing foods.[90]

Food manufacturers and retailers underscored the eye appeal generated by the color of foods in retail stores. In a 1917 article in the *American Food Journal*, the secretary of the National Confectioners' Association argued that the sense of sight had a "direct relation" to the palate: "The color attracts the eye, desire is created, and the color increases the palatability because the taste nerves are stimulated."[91] The chemical company DuPont, touting the advantage of cellophane's transparency, made a similar assertion to readers of *Manufacturing Confectioner*: "Your EYES can TASTE Cellophane-wrapped candy" (emphasis in the original).[92] The luscious color of foods became important not simply for the sake of aesthetics, but also for whetting consumer appetite. A 1928 market study conducted by DuPont reported that 85 percent of all buying was done by the eye.[93] Believing in such data, food manufacturers and retailers stressed the significance of visually focused marketing to appeal specifically to the desires of food shoppers.[94] As one grocer noted, color had become "one of the greatest forces in the world" in selling foods.[95]

Synthetic dyes filled various technical needs and provided economic benefits to food manufacturers, distributors, and retailers who faced new kinds of quality-control problems in the first decades of the twentieth century. As the market expanded nationally, food products were transported to various parts of the country and thus became subject to changes in surrounding conditions, including temperature and humidity. As self-service grocery stores began expanding in the 1920s and 1930s, food products were required to retain a relatively long shelf life.[96] After transparent film, particularly cellophane, became popular also in the 1920s and 1930s, the appearance of foods became an

[90] National Aniline, *Dyestuffs* 22, no. 9 (1921): 694.

[91] Walter C. Hughes, "Care of Confectionery," *American Food Journal* 12, no. 6 (1917): 329. See also Stroud Jordan, "Chemistry and Confectionery," *JIEC* 16, no. 4 (1924): 336–39.

[92] DuPont Advertisement, *Manufacturing Confectioner* 10, no. 3 (1930).

[93] DuPont, "Cellophane: Modern Merchandising Aid," pamphlet (1928), DuPont Advertising Department Collection, Hagley Museum and Library, Wilmington, Del.

[94] See "It Is the Eye That Says Buy!" *Meat Merchandising* 4, no. 9 (1928): 18–22; Henry Frommes, "The Eye Appeal in Selling," *Meat Merchandising* 5, no. 12 (1930): 24–27; and N. S. Gray, "Impulse Buying Builds Success for Nelson," *Progressive Grocers* 16, no. 6 (1937): 54.

[95] Arthur A. Poss, "Any VEGETABLE That Looks Nice," *Meat Merchandising* 2, no. 9 (1926): 9.

[96] For a history of self-service stores, see Tracey Deutsch, *Building a Housewife's Paradise: Gender, Politics, and American Grocery Stores in the Twentieth Century* (Chapel Hill, 2010); and James M. Mayo, *The American Grocery Store: The Business Evolution of an Architectural Space* (Westport, Conn., 1993).

important tool in their marketing and sale. Yet transparent packages posed a problem: foods were exposed to bright light in the store.[97] Synthetic dyes were more stable and less likely than natural dyes to fade due to changes in temperature, humidity, and strong lighting.

With the expansion of the certified-dye market, the safety of synthetic dyes also became a crucial part of the advertising rhetoric that dye manufacturers pitched to food processors. After passage of the 1906 pure food act, dye producers' marketing strategies shifted. While some dye makers replaced uncertified dyes with certified, others turned to natural colors instead of synthetic ones. By the 1910s, many butter color makers had switched back to annatto color extracts.[98] Butter color makers sought to ensure their customers of the safety of their products and emphasized that the coloring property of natural dyes was not inferior to synthetic products. Wells, Richardson & Company advertised its butter color as "purely vegetable," which met "the full requirements of all food laws—state and national." While stressing its products as harmless, the firm also suggested that its dye product was even better than synthetic dyes as regards to strength, stability, and uniformity.[99]

Government regulation and public concerns over food adulteration reallocated the competitive advantage that dye makers and food processors had retained. When synthetic dyes were introduced to the American food industry in the late nineteenth century, many dye and food producers abandoned natural colors as uneconomical. Technological and scientific advances in the chemical industry afforded synthetic dye makers and users a competitive edge over their competitors. By the 1910s, however, due to changes in the political and social climate, natural dye became an important commodity as a "safe" coloring material. Synthetic dyes were still used more widely by food producers than natural colors and remained highly competitive in the dye market. Yet as the 1906 act was enacted and harmlessness became an even more important feature of food colors than before, the commercial value of natural dyes increased. After annatto regained popularity among some dye and food producers (particularly butter makers), the amount of annatto imported from Jamaica to the American market increased, from 364,000 pounds in 1887 to 914,000 pounds in 1935.[100] By the

[97] DuPont, "Cellophane"; C. W. Ward-Jackson, *The "Cellophane" Story: Origins of a British Industrial Group* (Edinburgh, U.K., 1977).

[98] "Abolishing Coal Tar Colors," 2; "Butter Color Poison," 3.

[99] Wells, Richardson Advertisement, *Wisconsin Butter Makers' Association Twenty-Sixth Annual Meeting* (Fond du Lac, Wisc., 1926), 67.

[100] Georgia E. Cantrell, *Annatto* (Washington, D.C., 1944), 16; "Cultural Exports and Imports," *Bulletin of the Botanical Department Jamaica* 24, no. 39 (1893): 19.

mid-twentieth century, the United States became the world's largest importer of annatto, representing approximately one-fourth of the total global trade.[101]

Throughout the 1920s and 1930s, journalists, consumer groups, and cultural critics condemned the 1906 Pure Food and Drug Act as ineffective.[102] One of the shortcomings identified was the act's lack of authority to mandate use of certified dyes. After years of debate over more than a dozen proposals, Congress passed the Food, Drug, and Cosmetic Act in 1938. The act increased government oversight of food and drugs and, for the first time, regulated cosmetics and medical devices. Under the new legislation, the use of certified colors became mandatory.[103]

The 1938 act also established three categories of certified dyes by standardizing their nomenclature: FD&C for colors certified for use in foods, drugs, and cosmetics; D&C for colors certified for drugs and cosmetics; and Ext. D&C for colors not certifiable for ingestion, but considered safe for use in products applied externally. Each certified food dye was called FD&C, followed by the name of its basic shade and a number. For instance, trade name Guinea Green B became FD&C Green #1, while Light Green SF Yellowish was called FD&C Green #2.[104] The standardization of dye names provided administrators, scientists, dye makers, and food manufacturers with common vocabularies, allowing them to communicate more efficiently.[105] The new names also enabled dye users to distinguish certified colors from uncertified products much more easily because trade names, such as Guinea Green B, had not indicated whether a color was certified.

Although the 1938 act amended some of the flaws in the 1906 legislation, the new regulation did not fully solve the ambiguity in defining "harmlessness" and "safety." Under the statute, a dye could be used if it was "harmless and suitable for use in foods," and a food was deemed adulterated if the dye used was *not harmless*. The FDA interpreted the term "harmless," as well as "not harmless," based on the quantity of substances that people consumed. If the quantity of dyes involved in human consumption was so small that it did not render food injurious to health, the substance was deemed "harmless"—even if there was evidence that it

[101] F. J. Francis, "Lesser-Known Food Colorants," *Food Technology* 41 (1987): 62.

[102] See, for instance, Arthur Kallet and Frederick J. Schlink, *100,000,000 Guinea Pigs: Dangers in Everyday Foods, Drugs, and Cosmetics* (New York, 1933).

[103] Food, Drug, and Cosmetic Act, Pub. L. 75–717, §52, Stat 1040 (1938).

[104] Committee on Food Protection, National Research Council, *Food Colors* (Washington, D.C., 1971); and Hochheiser, "Synthetic Food," 102–10.

[105] On the standardization of terminology, see Stefan Timmermans and Steven Epstein, "A World of Standards but Not a Standard World: Toward a Sociology of Standards and Standardization," *Annual Review of Sociology* 36 (2010): 69–89.

had a poisonous effect on laboratory animals.[106] It was not until 1960 that the amendment to the 1938 act eliminated the term "harmless" from the statute and redefined certified food dyes as colors "suitable and safe" for food use.[107]

The regulation and increasing use of synthetic dyes helped to distance food production from consumers. Understanding the chemical composition of synthetic dyes required specialized knowledge. Dye names, such as Ponceau 3R and Naphthol Yellow S, or even standardized FD&C names, meant little to most consumers. Although consumers increasingly saw such terms as "certified dyes" and "pure food" on food packages and advertisements, food quality remained uncertain. The government standardization and certification of synthetic dyes required manufacturers to disclose certain information about food processing and dye production. Standardized colors, however, made it difficult for consumers to understand the relationships between color and food: Where did the color of food come from? Which dyes were safe to consume? What did "safe" color mean?

Conclusion

By 1938, when Congress enacted the Food, Drug, and Cosmetic Act, the food coloring business had become a central and permanent component of food marketing strategies. This was an immense change from six decades earlier. Before the 1870s, food coloring had held a marginal place in food businesses, as manufacturers simply dyed foods to make them look fresher, often by making coloring solutions themselves. Food dyes were not consistent in quality, and some of them were actually injurious to health. With the development of the synthetic food dye industry, standardized color became a source of competitive advantage, although it evolved over time as a norm for food manufacturers. As synthetic dyes became a common ingredient for foods and the federal government established the dye certification system in the first decades of the twentieth century, food-coloring practices became integrated into an entire strategy of manufacturing and marketing in the food industry.

The implications of the growth of the food coloring business were complex and manifold. For the food industry, economical and stable synthetic dyes afforded manufacturers a new way of coloring foods uniformly in desirable hues at greatly reduced prices. Masses of standardized, clean, bright food products became an indispensable feature of

[106] Certified Color Industry Committee v. Secretary of Health, Education and Welfare, 236 F.2d 866 (2nd Cir. 1956).

[107] Color Additives Amendments of 1960, Pub. L. 86–618, §74, Stat 397 (1960).

modern supermarkets. By glancing at beautifully arranged foods in window displays, shoppers looked at lines of shelves filled with colorful foods. The yellow color of pasta, pink and red colored sausages, candies with red, green, and blue shades—glaring, bright mixtures of hues beamed into consumers' eyes. With consistent control over the coloring of foods, food manufacturers and retailers created and presented a standardized, albeit artificial, notion of naturalness.

The expansion of food coloring practices facilitated the creation of new forms of regulation. Food coloring legislation served as an apparatus for government agencies to regulate food adulteration and to oversee the dye industry. Yet government officials and scientists endorsed food coloring as an important food manufacturing process by conducting food dye research, establishing grade standards for certified "safe" colors, and providing legislative definitions of foods and colors. The 1906 act marked not only the first federal legislation against food adulteration but also the creation of a new market for certified food dyes.

While synthetic food dyes enabled manufacturers to mass-produce and mass-market standardized, low-cost products consistently, the increasing use of chemical additives raised questions about public health. At the turn of the twentieth century, the popular media had already begun to publicize the health hazards of synthetic chemicals. As the use of food colors became more prevalent and the global food market grew, the standardization of color became a target of criticism from the consumer movement during the 1960s and 1970s. Consumer activists began to oppose the use of chemical additives in foods, especially questioning the safety of synthetic colors. Due to consumer protests against synthetic colors, the standardization of color moved from being an opportunity to being a challenge for food manufacturers.

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