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Standardized Color in the Food Industry: The Co-Creation of the Food Coloring Business in the United States, 1870-1940

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Harvard Business School

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Abstract

This working paper 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. Food manufacturers along with dye makers and regulators co-created the food coloring business. Synthetic food dyes provided the food manufacturers with new tools for shaping and standardizing the color of foods, which had previously been colored with dyes extracted from natural plants and organic minerals, helping them to achieve the mass production and mass marketing. Color was easier to control, reproduce, and commoditize than other sensory factors such as smell and texture. The federal Food and Drug Act of 1906 further assisted the management of product color in the food businesses by regulating and endorsing the industry's color control practices. By 1938, food dyes had achieved such widespread use, and had raised such public concern, that the federal government amended the 1906 Act to implement more stringent measures to regulate the industry.

Standardized Color in the Food Industry: The Co-Creation of the Food Coloring Business in the United States, 1870-1940[1]

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Introduction

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.[2] Within this emergent era of 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.[3] 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.[4] By 2015, the global food dye market had grown to roughly $1.5 billion.[5]

By examining the commercial significance of standardized color in the food industry, this paper 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.[6] To establish 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.[7] 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.[8] By analyzing how manufacturers created and marketed

food with uniform color, this paper 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 inter-industrial relations between the dye and food industries.[9] 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.[10] 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.[11]

While building on Hochheiser's work, this paper 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 standardize the color of foods on the market.[12] 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.[13]

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.[14] 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.[15] 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 triumph over nature.[16] 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.[17] 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.[18] 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.[19]

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.[20] 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."[21] Synthetic dyes were generally more stable 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.[22]

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.[23] 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. Chemical firms manufactured food dyes and sold them to food and beverage companies. 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.[24] With immense economic power and advanced technology, the German chemical industry helped to build globalization of the late nineteenth century by promoting the exchanges of dyestuffs, human resources, and financial capital. German immigrant entrepreneurs in the United States realized the economic potential of dyes that could rival products imported from Germany.

H. Kohnstamm & Company was among the first to recognize the potential profit of food colors. Joseph Kohnstamm moved to New York City in the 1840s to expand his family business in synthetic dye trading in Germany to the American market. In 1851, he founded Kohnstamm & Company as an importer and supplier of dyes to the textile, printing, and paint industries. After Kohnstamm's death, he was succeeded by his brother, and later by his cousin who reorganized the firm and established H. Kohnstamm & Company in 1876. Four years later the firm ventured into the manufacturing of synthetic dyes mainly for textiles and paints. H. Kohnstamm soon began developing food dyes and marketed them under the brand name "Atlas Colors."[25] The firm used dye ingredients imported from Germany and refined them for the American food industry.

Another pioneer of food dye manufacturing was the Aniline & Chemical Company of Buffalo, New York. Its founder, Jacob Frederick Schoellkopf, was a foresighted businessman, who successfully expanded several different businesses, including tanning, flour milling, and dye manufacturing, in the United States. Trained as a tanner in Germany, he had little knowledge of synthetic dyes when he moved to the United States in 1842. Schoellkopf founded the Aniline & Chemical Company in 1879, to meet increasing demand for cheap synthetic dyes from the textile

and paper industries. Schoellkopf was engaged primarily in management, and hired a German chemist to consult on the production of synthetic dyes with his two sons, who had studied chemistry in Germany. After Schoellkopf's death in 1899, his sons incorporated the Schoellkopf, Hartford & Hanna Company in 1900 by consolidating three dye companies that Schoellkopf had established.[26] After the merger, the company began experimenting with food dye production. By the early 1910s, it had become the leading dye manufacturer in the United States, with a 50 percent share of the market, including both food and non-food dyes.[27]

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.[28] In the early 1830s, the typical grocery list of an American family consisted largely of bread, meat, butter, potatoes, sugar, milk, and tea.[29] 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.[30] 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.[31] By 1920, virtually all households purchased some form of commercially processed foodstuffs, including margarine, canned foods, and candies.[32]

As processed foods were more likely than agricultural products to be colored with synthetic dyes, Americans consumed ever-increasing amount 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.[33] The Jell-O Company had replaced vegetable colors with synthetic dyes for coloring its popular gelatin dessert by the early 1930s.[34]

The dairy industry was one of the earliest to recognize the economic benefits of using synthetic dyes in the food industry. The coloring of 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.[35] 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.[36]

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.[37] 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.[38] 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.[39]

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—it never fades."[40] By the early 1900s, synthetic butter colors had displaced annatto and other vegetable dyes almost entirely.[41]

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.[42] Dairy associations regularly published articles in trade journals and farm newspapers to warn farmers not to "overlook the color" especially during winter.[43] 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.[44] 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 its 1916 advertisement, Wells, Richardson stressed the higher profitability of the "rich golden hue" of butter dyed with its product.[45] 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."[46] 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 of sugar price. By the early 1870s, penny candies had become ubiquitous, available in candy shops, corner stores, five-and-dime stores, and newsstands.[47] Confectioners quickly adopted synthetic dyes to maximize their profits.

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.[48] 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.[49] Coloring formulas and instruction helped confectioners to make a specific shade as the "natural" color of certain flavor 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.[50] 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.[51] 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].[52] These industry manuals suggested that the artificial coloring was an indispensable means for producers to create the finished product's "natural" appearance.

For many food manufacturers, synthetic dyes became one of the crucial ingredients to make foods look enticing during the first decades of the twentieth century. A 1906 article in the *Confectioners Journal* described the coloring of foods as "the natural and reasonable adornment of a product." The author noted that because people were surrounded by color in their everyday lives, it was "natural" for confectioners to "find it necessary to tint [their] various creations in pleasing shades."[53] As food producers attained economical and convenient ways of coloring foods, creating and controlling the visual appeal of taste became not only necessary for profitable sales but also relatively simple.

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 market even if the fruit was ripe inside.[54] 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.[55] Food producers used synthetic dyes also for coloring such perishable items as fresh meat, salmon, and sweet potatoes.[56]

Synthetic-Dye Regulation and Standards

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.[57] 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.[58] Newspapers reported a number of incidents in which brightly colored candies caused illness and sometimes death in children.[59]

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. In its 1903 article, entitled "Poison for Food Coloring," the *New York Times* reported that the Port of San Francisco denied the importation of synthetic dye "cherry fruit color" from Germany as it contained poisonous substances.[60] The *Chicago Tribune* published a speech by Senator Weldon Heyburn, who introduced a pure food bill to Congress, and alleged that "a large proportion of foods, drugs, and liquors were adulterated."[61] Harvey Wiley, the Chief of the Bureau of Chemistry in the U.S. Department of Agriculture (USDA), advocated the necessity of food regulation by publishing articles in popular and trade magazines and lecturing around the country. Wiley appeared in popular media so frequently that by 1905, "Dr. Wiley" had become a household name in the United States.[62]

H. Kohnstamm's food dyes were particularly popular in the confectionery industry as safe colors. At the 1906 annual convention of the National Confectioners' Association (NCA), the NCA's president "express[ed] gratitude" to H. Kohnstamm for its "persistent and highly intelligent efforts to overcome the prejudices of Public Officials against the use of harmless coal tar colors."[63] The NCA's Executive Committee also recognized the firm's "constant, able and scientific work"

in the interest of the confectionery industry. The Executive Committee endorsed and recommended that NCA members use H. Kohnstamm's food colors, which had "always properly defend[ed] any attacks on the quality of confectionery where the coloring [was] questioned."[64] Confectioners were eager to eradicate government officials' and consumers' "prejudices" against dyes used for their products, incited by newspapers reporting a number of incidents where brightly colored candies caused children's illness and sometimes death. Although confectioners vehemently denied that their products were injurious to health, medical professionals and government scientists asserted the toxicity of dyes used for confectionery, particularly inexpensive candies.[65]

Confectioners did demand for "harmless" colors, however, and in response H. Kohnstamm and other dye producers supplied various new food dyes to the confectionery industry, claiming that their dyes were safer, purer, and more reliable than any other brands.[66] When the NCA acknowledged H. Kohnstamm's "intelligent efforts" for the industry at the 1906 annual convention, the company publicized the endorsement from the NCA in the trade journal *Confectioners' and Bakers' Gazette*, seeking to demonstrate that H. Kohnstamm was the leader of harmless synthetic dye manufacturing.[67]

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 poisonous substances to confectionery.[68] 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, politics was transformed fundamentally by what historian Uwe Spiekermann calls a "nutrient paradigm."[69] 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.[70] 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.[71] 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.[72]

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.[73] 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.[74] 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.[75]

To have dyes certified, dye makers were required to submit each batch (a single lot of dye processed at one time) separately, along with an affidavit specifying the ingredients in the proposed mixture, the weight of each ingredient, the total weight of the batch, and the method of mixing. Scientists in the Bureau of Chemistry then investigated whether the dyes submitted met the USDA's quality standard. If the seal on a package of certified colors was broken, the contents were no longer considered "certified." If certified colors were mixed with liquid or other dyes (certified or uncertified), manufacturers had to resubmit the finished product for certification.[76]

None of the seven certified colors was patented, and thus their manufacture was open to any producer competent to make them.[77] 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.[78] 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.[79] 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.[80]

The United States was a latecomer in food coloring regulation. In England, the Sale of Food and Drugs Act of 1875 banned mixing injurious ingredients, including colors, with food.[81] Germany's 1887 Color Act prohibited the use of food colors detrimental to health.[82] 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.[83]

Nor was the American legislation fully effective. Contrary to Hesse's proposition, the USDA did not require the use of certified food dyes. There were so many dyestuffs on the market that it was virtually impossible for the Bureau of Chemistry to investigate every single dye and determine which colors were unsafe for food consumption. 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.[84] It was not until the amendment of the 1906 act in 1938 that the USDA mandated the certification of food dyes.

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.[85] Believing that the government would eventually require the use of certified colors, dye companies began experimenting with the seven certified dyes.

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 confectionery industry was one of the first industries that H. Kohnstamm approached as a major outlet for its certified colors. In December 1907, the firm published an advertisement in *Confectioners' and Bakers' Gazette* to inform confectioners as to the newly established certification system, and announced that the company was about to complete the development and manufacturing of certified colors.[86] But it took H. Kohnstamm and its rival Schoellkopf two more years to manufacture certified dyes successfully on a commercial scale. In 1909, the two firms launched promotion campaigns to notify food and beverage producers and other dye makers that they were accepting orders for the seven certified colors.[87] "The advertising advantage to those using Certified Colors can readily be seen," H. Kohnstamm noted in its advertisement, featured in the trade magazine *American Food Journal*.[88] To promote the use of certified dyes, both companies explained the introduction of Food Inspection Decision 76 and asserted that government certification would serve as a marker of food quality and safety.

The sales of the certified colors disappointed H. Kohnstamm and Schoellkopf, however. They complained to USDA chemist Bernhard Hesse that the business in certified colors was "very slack" and that food and dye makers would not "take to them unless some pressure [was] brought to bear."[89] H. Kohnstamm initially had believed that without any government pressure, certified food colors would displace uncertified dyes once they became available in greater quantities.[90] In February 1909, the company's president E. G. Kohnstamm told Hesse that he was "surprised how little interest his announcement of [1909] with respect to certified food colors [had] awakened" and suggested that requiring certified food colors might be necessary.[91] Hesse proposed to Chief of the Bureau of Chemistry Harvey Wiley repeatedly that certified food colors should be

mandatory.[92] Frustrated by the slowness of USDA officials, Hesse wrote to Wiley: "Unless there are reasons unknown to me, I can not see why it would not be proper to give some official notice that on and after, say, March 1, 1910, nothing but certified colors could be used."[93]

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.[94] In the *American Food Journal*, the Food Commissioner of Iowa urged food processors to use only certified colors, as a means of combatting popular suspicions of the dangers of synthetic colors. He argued that there could be "no better rebuttal than colors the U.S. Government itself had guaranteed as safe."[95] 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.[96]

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.[97] 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."[98] The Color Laboratory certified food dyes and provided government control and supervision over dye manufacturing.[99] To support the chemical industry in dye investigations and

production, the laboratory compiled American 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.[100] 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.[101] 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).[102] 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."[103] 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.[104] 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 stores nationally.[105] In many European nations, it was not until after World War II that self-service supermarket merchandising expanded.[106] 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, textile, art, and foods.[107] 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."[108] 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 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 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.[109]

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."[110] 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).[111] Colors did not add flavor to food but helped consumers imagine its taste, as well as its smell and texture. A 1928 market study conducted by DuPont reported that 85 percent of all buying was done by the eye.[112] Believing in such data, food manufacturers and retailers stressed the significance of visually focused marketing to appeal specifically to the desires of food shoppers.[113] As one grocer noted, color had become "one of the greatest forces in the world" in selling foods.[114] The luscious color of foods became important not simply for the sake of aesthetics, but also for whetting consumer appetite.

In self-service stores, brightly colored food products became an indispensable part of visually-stimulating food displays. The rise of self-service supermarkets in the first decades of the twentieth century altered consumers' food purchasing experience, transforming the relationships between customers and store clerks.[115] Consumers' sensory experience also changed dramatically.

Until the first decades of the twentieth century, many grocery stores provided American consumers with limited sensory access to goods. Although consumers could see, smell, and touch some goods in a store, many products were physically out of their reach since they were displayed behind the counter or stored in a backroom. Newly established self-service stores thrust consumers into a color-saturated and sanitized environment. As visual appeal became highly important in food retailing, food color became a significant marketing tool for food manufacturers and retailers to convey standardized ideas about goodness, naturalness, and freshness of foods.

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 1930, food products were required to retain a relatively long shelf life. After transparent film, particularly cellophane, became popular also in the 1920s and 1930s, the appearance of foods became an important tool in their marketing and sale. Yet transparent packages posed a problem: foods were exposed to bright light in the store.[116] 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 became a crucial part of the advertising rhetoric that dye manufacturers pitched to food processors. After the 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.[117]

Butter color makers sought to ensure their customers of the safety of their products and emphasized that the coloring property of natural dyes were 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.[118]

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 even more important features 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.[119] By the mid-twentieth century, the United States became the world's largest importer of annatto, representing approximately one-fourth of the total global trade.[120]

While certified dye consumption continued to grow in the 1930s, journalists, consumer groups, and cultural critics condemned the government's ineffective and inadequate food regulation policies and corporate greed, which endangered the public health. For example,

100,000,000 Guinea Pigs, published by economist Arthur Kallet and engineer Frederick J. Schlink in 1933, aroused consumers' suspicion of corporate activities and various commercial goods, especially foods and medicines. Kallet and Schlink argued that the American public were "used as a guinea pig" of companies that marketed their products with little knowledge or concern about their impact on consumer health.[1] The book went through thirteen printings in its first six months and became one of the best-selling books of the decade.[2]

The book also catalyzed a movement for reform in the food regulatory system under the 1906 Food and Drug Act, which some scientists and government officials had long considered inadequate. One of the shortcomings identified was the act's lack of authority to mandate use of certified dyes. To implement food regulation more effectively, the federal government reorganized the Bureau of Chemistry in 1927. The Bureau's research function was transferred to the newly established Bureau of Chemistry and Soils in the USDA. Another new agency, the Food, Drug, and Insecticide Administration (FDIA), took over the major regulatory responsibilities of the Bureau of Chemistry, including enforcement of food regulation and investigations of adulterated foods. In 1930, the FDIA was renamed the Food and Drug Administration (FDA). The new government body, however, did not transform the existing food regulatory policies.

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.[121] 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;

[1] Arthur Kallet and Frederick J. Schlink, *100,000,000 Guinea Pigs: Dangers in Everyday Foods, Drugs, and Cosmetics* (New York: Vanguard Press, 1933), 18.
[2] McGovern, *Sold American*, 245.

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.[122] The standardization of dye names provided administrators, scientists, dye makers, and food manufacturers with common vocabularies, allowing them to communicate more efficiently.[123] 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 had a poisonous effect on laboratory animals.[124] 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.[125]

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 working paper has shown how food manufacturers, dye makers and regulators had co-created the food coloring business.

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 by 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 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 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 also 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.

Endnotes

[1] I would like to thank Walter Friedman, Roger Horowitz, Geoffrey Jones, Susan Strasser, and David Suisman for their insightful comments on an earlier draft of this working paper. The revised version of this working paper will appear in the *Business History Review*.

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