


Research Article

New Natural Food Colour: 'Dracula-red'

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Abstract

Red food colourants play a central role in consumer perception and product appeal, yet many synthetic dyes face increasing regulatory scrutiny due to potential health risks, while natural alternatives often suffer from instability under heat, light, or acidic conditions. This study introduces *Dracula-red*, a novel red colourant produced from turmeric, sodium bicarbonate, and citric acid through brief exposure to low-heat microwave frequencies. The method uses ingredients generally recognised as safe and yields a visually intense, heat-stable red hue suitable for culinary applications. Colour measurements obtained via mobile RGB analysis and converted to CIELAB space indicate a pronounced perceptual shift ($\Delta \approx 55$) from yellow to deep red. Classical acid–base explanations do not account for the transformation, which occurs only under microwave excitation. A resonance-based, vibrational phase-locking hypothesis is proposed to explain this behaviour, supported by the reversible return to yellow upon dilution with ethanol or vinegar. The resulting colour may be described as a *pseudo-colour*, arising from a specific physical configuration rather than a permanent chemical modification. This proof-of-concept demonstrates a simple, reproducible approach to generating a natural red colourant and highlights the need for further spectroscopic and structural studies to characterise the underlying mechanism and assess broader applications.

Keywords: Red; Dracula-red; Food colour; Colourant; Resonance; Optical; Curcumin; Turmeric

Introduction

Food colourants play a critical role in shaping consumer perception, influencing expectations of flavour, freshness, and quality. Among these, the colour red holds particular commercial importance due to its strong associations with appetite stimulation, excitement, and visual appeal across confectionery, beverages, baked goods, and cosmetics. As global demand for food colourants increases, concerns about the safety of synthetic dyes have intensified. Several widely used artificial reds have been linked to allergic reactions, behavioural effects in children, and potential carcinogenicity, prompting regulatory restrictions and renewed interest in natural alternatives [1][10].

Natural red colourants such as beetroot extracts offer safer profiles but often suffer from instability under heat, light, or acidic conditions [8][12]. This creates a persistent challenge for manufacturers seeking vibrant, stable, and ethically sourced red hues. In this context, the development of new natural colourants that combine safety, stability, and ease of production is of significant industrial relevance.

This paper introduces '**Dracula-red**', a novel red colourant produced

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from turmeric, sodium bicarbonate, and citric acid using brief exposure to low-heat microwave frequencies. The method is simple, reproducible, and based entirely on ingredients generally recognised as safe. The resulting colour demonstrates strong visual intensity and stability under cooking conditions, offering a promising alternative to existing natural and synthetic red dyes. The paper further explores the physical and chemical considerations underlying the colour transformation and proposes a resonance-based hypothesis to account for observations not explained by classical acid–base behaviour.

Historically, red food colourants have been derived either from natural sources, like beetroot, which can be unstable under heat and acidic conditions [8][12], or from synthetic dyes that have raised serious health concerns, including allergic reactions, hyperactivity in children, and potential carcinogenic effects. These challenges have intensified the demand for safer, natural alternatives.

Food colourants are also used in various non-food applications, including cosmetics, pharmaceuticals, home craft projects, and medical devices. In the manufacturing of foods, beverages, and cosmetics, the safety of colourants is under constant scientific review and certification by national regulatory agencies, such as the European Food Safety Authority (EFSA) and US Food and Drug Administration (FDA).

The Food Colour ‘Dracula-red’:

This paper introduces 'Dracula-red', an innovative natural red food colour/colourant developed entirely from sustainable ingredients: Turmeric, baking soda, and citric acid (or lemon juice). Dracula exhibits exceptional colour intensity and stability under high temperatures—addressing some limitations of existing natural and synthetic options. Moreover, it avoids the ethical and health issues associated with animal-derived red hues. Although crafted from natural components, the underlying technology and application methods behind 'Dracula' are advanced, offering a promising and cutting-edge solution for the modern food industry.

Materials and Methods

The paper introduces a method of preparing a vibrant red food colour that is derived from plant-based sources. The colour is extracted using a non-toxic, environmentally friendly process that ensures the purity and safety of the final product. The new red food colour is stable under a wide range of temperature and humidity, making it suitable for use in various food and beverage applications.

The red food colour derived from plant-based sources is not produced, as normally done, by extracting pigments from sources such as beetroot, red cabbage, and other red-hued fruits or vegetables but by converting the bright yellow pigments of turmeric/curcumin into deep red. It is likely

Table 1: List of the eight approved food colouring.

List of the Nine Approved Food Colouring Additives			
Dye (Approved)	Common Foods	Risk to Humans	Notes
Blue 1 (1969)	Beverages, candy, baked goods.	Small cancer risk to animals. May be safe to humans who are not allergic.	Needs more testing.
Blue 2 (1987)	Pet food, beverages, candy.	Some evidence it may cause brain cancer in male rats	FDA affirms its safety.
Citrus red 2 (1963)	Skin of some Florida oranges.	Very low.	Rarely used.
Green 3 (1983)	Candy, beverages.	1981 study: Possible bladder and testes cancer in male rats.	FDA affirms its safety. Not widely used.
Orange B (1966)	Sausage casings.	In high doses, it is harmful to liver and bile duct.	Hasn't been used in many years.
Red 40* (1971)	Soda pop, candy, gelatin desserts, pastries, pet food, sausage.	May cause allergy-like reactions, hyperactivity, including ADHD. Some studies show it's a carcinogen in animals.	The most widely used food dye, but is facing restriction in some USA states and ban in others.
Yellow 5 (1969)	Gelatin desserts, candy, pet food, baked goods.	Causes allergy-like reactions, hyperactivity, including ADHD. Some studies show it's a carcinogen in animals.	The second most widely used dye.
Yellow 6 (1986)	Beverages, candy, baked goods.	Causes tumours of adrenal gland and kidney in animals.	The third most widely used dye. FDA says
Oct 2022: 24 organizations and prominent scientists urged the FDA to remove Red 3 from approved colour additives in food, dietary, and oral medications.			

(Source: Center for Science in the Public Interest: Adopted from Patton (2025)) [1]

produced by forcing the bright yellow colour pigments of turmeric to vibrate on a lower frequency and thus appearing red. Further discussion on the mechanism by which the colour of the turmeric changes from bright yellow to bright red is to follow.

The list of ingredients for this colour is:

- 1 part turmeric/curcumin;
- 1 part sodium bicarbonate;
- 1 lemon juice or diluted citric acid;
- 1 part water;
- 1 part plain flour (regular or gluten free) to adjust viscosity and consistency of the resulting pigmentation.

The mixture's colour is yellowish white before processing. The mixture is then exposed to a lower end of 195 MHz/2450 MHz of microwaves (defrosting) for 50 seconds. The food mixture instantly turns vibrant red with different shades depending on the thickness of the blend and exposure to light; blood red; chilli pepper; etc. (see figure 1) and is stable to cooking conditions such as high temperature.

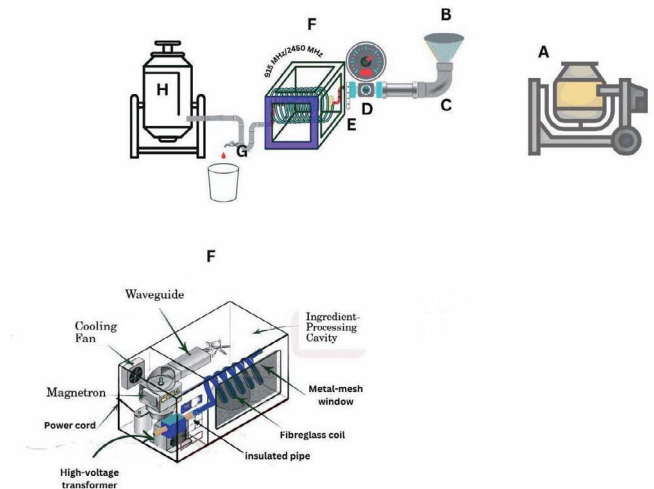


Figure 1: RGB Comparison of Colour & Shades Before and After Processing.

The process involves the use of water or oil as a carrier, followed by filtration if needed. The colour could also be applied as a paste with no filtering. The final product, therefore, is liquid or paste.

The resulting red food colour is free from synthetic additives, preservatives, and animal-derived ingredients. That makes it non-toxic, non-allergenic (if preferred), and safe for consumption by individuals of all ages; processed by a home-safe level of microwave frequencies for a brief duration.

This red food colour/colourant results from manipulating the yellow pigmentations present in turmeric into a new perceived appearance; vibrant red! This is possible to prepare at an industrial level (see figure 2), but also at home, by processing turmeric (curcumin) with additional food ingredients, namely, bicarbonate of soda, and citric acid. The conversion process involves exposing the blend of turmeric and additional food ingredients to 195 MHz/2450 MHz of microwaves for 30-50 seconds. The blend then instantaneously turns vibrant red (figures 1 and 3). The red food colour of claim, is generally stable for the duration of its shelf life.



- A) A mixer for blending the ingredients evenly together in oil or water
- B) A funnel to decant the mixture in the processor. C/D) a valve with a barometer to regulate the flow of liquid based on the process desired speed.
- E) A fibreglass microwaveable coil tube to be filled with the liquid before starting the modified microwave unit.
- F) An insulated cavity where the ingredients are exposed to even distribution of 195 MHz/2450 MHz of microwaves for 50-60 seconds at a low voltage. The processed fluid is then pushed outside using a manual or an automatic pump at the end A or E.

G/H) The product is decanted into a small container (G) or a bigger container (H) depending on the amount processed. The resulting fluid may be used as is or further filtered for further purity and consistency. Filtering the product is optional and is not covered by this drawing. patent application number GB2500361.7; TM application number 00004146620; UK Copyright Service Registration Number: 284757667.A technical design for processing the ingredients to produce the colour. (please check open access statement)

Figure 2: A design of an equipment to process the colour.

At-Home Production

It's possible to produce this colour at home with careful processing. A thin layer of turmeric, baking soda, and lemon juice plus water will turn red if placed in the microwave for 30 seconds in a microwaveable container at the defrosting degree. The evenness of the product is not guaranteed if produced at home but it still can add a pleasant hue to many recipes.

Results

Colours were measured using 'Color Meter - RGB HSL CMYKRYB' free application [3]. Exposure of the ingredients blend has resulted in a pronounced transformation of colour from yellow hues to blood-red/crimson hues. Because the intended use of the colourant is domestic and commercial food presentation, perceptual colour differences are of primary relevance. Mobile RGB capture provides a practical and reproducible method for quantifying visible colour changes

without requiring specialised spectrophotometric equipment. This approach is appropriate for a proof-of-concept study, where the objective is to document the magnitude of the perceptual colour shift rather than to perform full spectral characterisation. The subsequent conversion to CIELAB and ΔE provides a robust, industry-standard measure of perceptual colour difference, which in this case ($\sim 55 \Delta E$) is sufficiently large that high-precision instrumentation is not required to confirm the effect.

The range for the "before" colour was a brighter yellow (RGB 255, 219, 30) to a deeper yellow (RGB 191, 106, 41), and for the "after" colour from a blood red/maroon (RGB 136, 42, 20) to a chilli-pepper variant (RGB 203, 39, 0). An average for these values within each range has been calculated to get a representative colour measurement for each state. For instance:

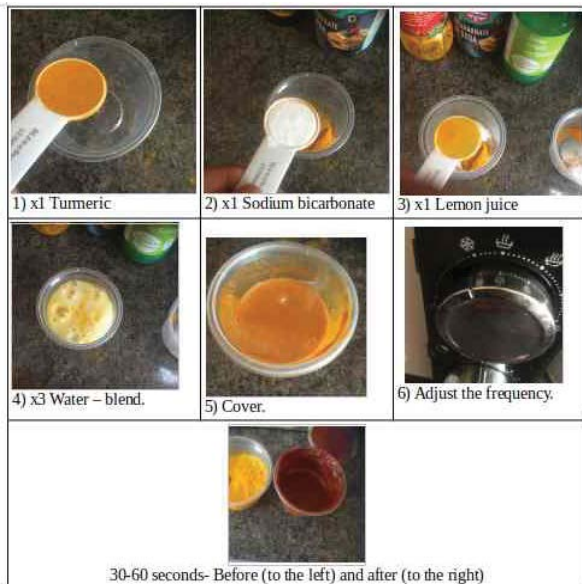


Figure 3: Steps and resulting colour versus original colour.

- Before (averaged):

- R: $(255 + 191) / 2 \approx 223$
- G: $(219 + 106) / 2 \approx 163$
- B: $(30 + 41) / 2 \approx 36$

- After (averaged):

- R: $(136 + 203) / 2 \approx 169$
- G: $(41 + 39) / 2 \approx 40$
- B: $(16 + 0) / 2 \approx 8$

- Converting RGB to CIELAB:

Using the CIELAB colour space [4] to obtain data more representative of how humans perceive differences in colour [7][13], the following values were calculated - Using ImageJ software:

- Before: $L \approx 70, a \approx 11, b \approx 67$
- After: $L \approx 37, a \approx 51, b \approx 48$

- Quantifying the Difference (ΔE):

$$\Delta E = \sqrt{(L37-L70)^2 + (a51-a11)^2 + (b48-b67)^2}$$

Given:

- **Before:** $L_{before}=70, a_{before}=11, b_{before}=67$
- **After:** $L_{after}=37, a_{after}=51, b_{after}=48$

Then,

$$\Delta L = 37 - 70 = -33$$

$$\Delta a = 51 - 11 = 40$$

$$\Delta b = 48 - 67 = -19$$

and,

$$\Delta L^2 = (-33)^2 = 1089$$

$$\Delta a^2 = (40)^2 = 1600$$

$$\Delta b^2 = (-19)^2 = 361$$

$$\text{Sum} = 1089 + 1600 + 361 = 3050$$

$$\Delta E = \sqrt{3050} \approx 55$$

This shows that the colour difference between the "before" and "after" states is approximately **55 ΔE** , indicating a very pronounced change [6].

The use of a mobile application ensures that the colour change can be independently verified using widely accessible tools, increasing reproducibility for researchers and industry practitioners who may not have access to spectrophotometric equipment.

Discussion

The colourant produced in this study is composed exclusively of ingredients that are widely regarded as safe for consumption, including turmeric, sodium bicarbonate, and citric acid. The transformation from yellow to deep red is visually striking and highly stable under cooking conditions, suggesting potential applications in pastries, coatings, and confectionery. However, the underlying mechanism of this transformation remains an open question requiring further investigation.

Classical explanations for curcumin's colour changes—such as deprotonation under alkaline conditions or complex formation with boron—do not fully account for the observations in this study. The mixture of turmeric, bicarbonate, and acid remains yellow-white when combined, and no red colour develops without microwave exposure, even though alkaline conditions are present. Moreover, the transformation occurs under low-heat microwave settings, where thermal degradation is minimal. These findings indicate that the colour change may involve a physical process rather than a purely chemical one.

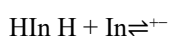
A plausible interpretation, consistent with the author's broader resonance-based research, is that microwave excitation induces a temporary vibrational or **phase-locking** state within the curcumin–bicarbonate matrix. Microwaves primarily interact with dipolar molecules, producing rotational and vibrational alignment even at low power. Such vibrational coherence may alter the effective conjugation length or electronic environment of the chromophore, shifting its absorption profile toward the red region. The subsequent reversion to bright yellow upon dilution with ethanol or vinegar—where the physical structure of the mixture is disrupted—supports the idea that the red state depends on a specific physical assemblage rather than a permanent chemical modification.

In this context, the product may be described as exhibiting **pseudo-colour**: a colour state that arises from a particular physical configuration of the mixture rather than from the formation of a new chemical compound. This interpretation aligns with known examples in nature where structural or vibrational phenomena, rather than pigment chemistry alone, generate vivid colours.

Further research is needed to determine whether the transformation involves subtle chemical changes, purely physical resonance effects, or a combination of both. Spectroscopic analysis, structural characterisation, and controlled microwave-frequency studies would help clarify the mechanism and assess long-term safety and stability. Despite these uncertainties, the reproducibility, intensity, and stability of the colour produced suggest that 'Dracula-red' warrants further exploration for culinary and commercial applications.

The Mechanism of Colour Change

Curcumin is cited in some classroom activities as an acid-base indicator [9]. It is said to change to red when it comes in contact with alkaline base – which is not the case in our experiment. Its colour change is thought to be rooted in alterations to its conjugated system, which are normally triggered by deprotonation under alkaline conditions. In an alkaline environment, one of curcumin's active hydrogen atoms is said to be removed, usually from its enolic group. This shift extends and modifies the delocalized π -electron system in the molecule, thereby altering the wavelengths of light it absorbs and, consequently, its apparent colour.



Additionally, curcumin is also used as a boron detector. When curcumin comes into contact with boron (typically present as boric acid or its derivatives), the process is said to be governed not by proton exchange but by coordination chemistry. Despite boron's characterization as an acid, it behaves as a Lewis acid—it accepts electron pairs rather than donating protons. Curcumin contains carbonyl and hydroxyl

groups that are capable of donating electron density, and when these interact with boron, a chelate complex is formed. This coordination leads to a reorganisation of curcumin's electron cloud in a manner similar to the effect of deprotonation: the effective conjugation of the molecule is altered, which then shifts its absorption characteristics and results in a colour change.

In essence, although the underlying mechanisms differ—the alkaline-induced colour change results from deprotonation while the boron-induced change stems from complex formation—both pathways ultimately modify the electronic structure of curcumin.

This is a striking case in which coordination chemistry induces a response that mimics the effect of a change in pH.

In this study, the classical acid–base explanation for curcumin's colour change does not fully account for the observations. The mixture of turmeric, bicarbonate, and citric acid remains yellow–white when combined, and no red colour develops in the absence of microwave exposure, even though alkaline conditions are present. Furthermore, the colour transformation occurs under low-heat microwave settings (defrost mode), where thermal degradation is minimal. These findings suggest that the mechanism may involve a physical process rather than a purely chemical one.

One possible explanation, consistent with the author's broader resonance-based research [11], is that microwave excitation induces a temporary vibrational or phase-locking state within the curcumin–bicarbonate matrix. Microwaves at 195–2450 MHz primarily interact with dipolar molecules, producing rotational and vibrational alignment rather than significant heating at low power. Such vibrational coherence could alter the effective conjugation length or electronic environment of the chromophore, shifting its absorption profile toward the red region. The subsequent reversion to yellow upon dilution with ethanol—where the physical structure of the mixture is disrupted—supports the idea that the red state depends on a specific physical assemblage rather than a permanent chemical modification.

This resonance-based interpretation is proposed as a working hypothesis to account for the observed behaviour and does not exclude contributions from known chemical pathways. Further spectroscopic studies would be required to fully characterise the underlying mechanism.

Product Safety

Turmeric in general is deemed safe to consume at reasonable levels. There is no reference intake recommendation, however, for turmeric (curcumin) at this point. With lots of possible health benefits such as reducing inflammation, more studies are required to determine its level beyond the use as a popular spice. Sodium bicarbonate and lemon juice are similarly considered safe ingredients.

Product Stability

The stability of this colour is dependant on the stability of its consistency. When diluted with water, it keeps its intensity. When stabilised in a product, like a pancake or pastry, it sustains its integrity. Once the physical compound is ‘dis-assembled’ by ethanol or vinegar dilution, however, it reverts to its original colour: bright yellow! Its usability for colouring, as a result, is dependant on the stabilisation of its physical assemblage and vibrational integrity - as strange as that may sound. In fact, many of the strikingly colourful phenomenon in nature occur due to vibrational resonance rather than the traditional colour pigmentations [5][2]. Try it for yourself (figure 4). More studies on its potential applications in food preparation are needed. This remarkable reversal of colour by what otherwise would be ‘extraction’ of turmeric from a solution, supports the mechanical interpretation of the transformation over the chemical one. The inclusion of citric acid (or lemon juice) contributes an additional layer of stability to the colourant. Citric acid lowers the pH of the mixture, inhibiting microbial growth and reducing the need for added acidic preservatives. As a natural chelating agent, it also binds metal ions that could otherwise catalyse oxidative degradation, thereby supporting colour integrity. Furthermore, by moderating alkalinity and maintaining the micro-environment required for the pseudo-colour state, citric acid helps preserve the physical assemblage responsible for the red appearance.

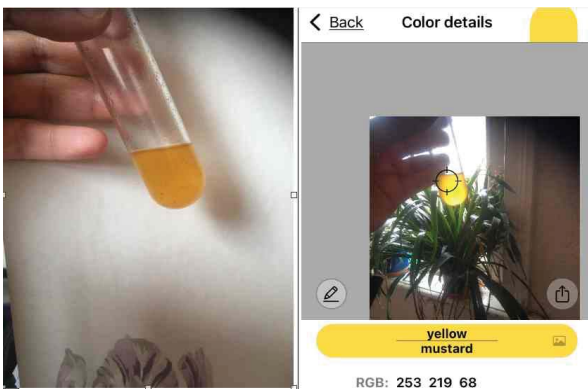


Figure 4: The red colour reverts back to bright-yellow once the turmeric is diluted (technically, extracted) in ethanol or vinegar.

Potential uses

The visual intensity, heat stability, and ingredient safety profile of *Dracula-red* suggest a range of potential applications in both domestic and commercial food preparation. Because the colour remains stable during baking and frying, it is particularly suitable for use in pastries, cakes, biscuits, and deep-fried batters, where high temperatures typically degrade natural red pigments. Its strong chromatic saturation also makes it appropriate for confectionery coatings, chocolates, decorative glazes, and sugar-based products, where vivid colour is desirable.

The ability of the colourant to disperse in both aqueous and oil-based carriers expands its applicability to sauces, fillings, icings, and compound coatings. Furthermore, the pseudo-colour behaviour—where the red hue depends on the physical structure of the mixture—may enable innovative uses in layered desserts, structural colour effects, or products designed to change appearance when exposed to solvents such as vinegar or alcohol.

Given its natural composition and simple production method, *Dracula-red* may also appeal to manufacturers seeking clean-label, plant-based, and allergen-friendly alternatives to synthetic dyes. Further research may reveal additional applications in food design, artisanal production, and culinary innovation.

Conclusion

The need for food colours/colourants are on the rise. This paper explains an innovative way to turn turmeric bright yellow into intense red colour. The safety of the colour is of the safety of its ingredients which are all natural and are generally considered safe to consume. Turmeric, furthermore, is known to have health benefits such as anti-inflammation properties if consumed in a reasonable dosage. There is no recommended reference intake for turmeric and further research has been recommended. The colour product described in this paper may be pseudo-colour, meaning it only appears red as the mixture maintains its viscosity and consistency while reverting to its original colour if diluted using solvents as ethanol or vinegar. Despite the challenges and the need for further research, it's worth investigating the possible applications of this colour ‘Dracula-red’. The naming of the colour is due to its dramatic blood-red hue. Using it in pastry, cakes, and candy might suit its properties while other applications might develop at a later stage.

Declarations

Authorship

I hereby declare that this paper is original research and that I'm the sole author.

Conflict of interest

I hereby declare that I have no conflict of interest in the publication of this research.

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