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Color Removal of Dye and Milk Wastewater Using Peanut Hull by the Process of Adsorption

Venkatesh Kummarakuntla
Cleveland State University

COLOR REMOVAL OF DYE AND MILK WASTEWATER USING PEANUT HULL BY THE PROCESS OF ADSORPTION AND MICRO-FILTRATION

VENKATESH KUMMARAKUNTLA

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We here by approve this thesis

for

VENKATESH KUMMARAKUNTLA

Candidate for the Master of Science in Environmental Engineering for the

Department of Civil and Environmental Engineering

and CLEVELAND STATE UNIVERSITY'S

College of Graduate Studies by

Dr. Yung-Tse Hung, Thesis Committee Chairperson Date

Department of Civil and Environmental Engineering

Dr. Walter M. Kocher Date

Department of Civil and Environmental Engineering

Dr. Chung-Yi Suen Date

Department of Mathematics

Dr. Lili Dong Date

Department of Electrical Engineering and Computer Science

Dr. Howard H. Paul Date

Department of Information Systems

Student's Date of Defense: May 1, 2018

DEDICATION

This thesis is dedicated to my parents.

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ABSTRACT

Dairy industry is one of the major industries from which organic wastewater is produced and released into the water bodies. Textile industries also generate considerable amount of dye wastewater that effect the water quality standards. Various treatment techniques are adopted to treat the wastewater. Adsorption is one of the low-cost treatment processes to treat the textile and milk wastewater.

This thesis focusses on the treatment of combined dye and milk wastewater using the process of adsorption. The treatment process is carried out by using three different types of low cost adsorbents Peanut-hull, Banana peel and Activated carbon. The effectiveness of the adsorbents was analyzed by measuring the transmittance values after the water has been treated.

Key words: Adsorption, Transmittance, textile wastewater, Milk wastewater.

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CHAPTER I

INTRODUCTION

1.1 Introduction

The dairy industry includes the transformation of raw milk into pasteurized and sour milk, yoghurt, hard, soft and cottage cheese, cream and butter products, ice cream, milk and whey powders, lactose, condensed milk, as well as several types of desserts. The general distinctions among these foods are due to the reuse of non-fat milk and whey (a by-product in cheese manufacturing) and the evaporation of the free water from the coagulum as well as from milk and whey powders. With the rapid industrialization observed in the last century and the growing rate of milk production (around 2.8% per annum), dairy processing is usually considered the largest industrial food wastewater source. Moreover, in around 50% of the world's whey production, especially concerning acid whey, it is untreated prior to disposal. The effluents originating from various production technologies are not discharged simultaneously, thus forming a stream with wide qualitative and quantitative variations. Notwithstanding the differences in composition, attributable to the manufactured product and technological operations, dairy effluents are distinguished by their relatively increased temperature, high organic content, and a wide pH range, which requires special purification to eliminate or reduce environmental damage. Treatments of dairy wastewaters include the application of mechanical, physicochemical, and biological methods. Mechanical treatment is necessary to equalize volumetric and mass flow changes. It also reduces parts of the suspended solids. Physicochemical processes are effective in the removal of emulsified compounds, but reagent addition increases water treatment costs. Another disadvantage is the very low elimination of soluble chemical oxygen demand (COD).

Producing milk, butter, cheese, or yoghurt, using pasteurization or homogenization produces wastewater with high levels of BOD and COD loads and must be reduced before being discharged to municipal treatment facilities (1). Typical by-products include buttermilk, whey, and their derivatives. Copious amounts of water are used during the process producing effluents containing dissolved sugars and proteins, fats, and possibly residues of additives.

The wastewater may contain pathogens from contaminated materials or production processes. A dairy often generates odors and, in some cases, dust, which also need to be controlled.

The reuse of wastewater from the dairy industry can also be provided for by usage of adsorption and membrane separation among other processes. The color and the odor may be removed completely after activated carbon treatment. The pretreated water can be passed through a cross flow reverse osmosis membrane system and the permeate water can then be reused. These effluents have the following characteristics

- Biochemical oxygen demand (BOD), with an average ranging from 0.8 to 2.5 kilograms per metric ton (kg/t) of milk in the untreated effluent (2)
- Chemical oxygen demand (COD), which is normally about 1.5 times the BOD level

- Total suspended solids (TSS), at 100–1,000 milligrams per liter (mg/l)
- Total dissolved solids (TDS): phosphorus (10–100 mg/l), and nitrogen (about 6% of the BOD level).

Cream, butter, cheese, and whey production are major sources of BOD in wastewater. The waste load equivalents of specific milk constituents are:

1 kg of milk fat = 3 kg COD

1 kg of lactose = 1.13 kg COD

1 kg protein = 1.36 kg COD

Dyes may be defined as substances that, when applied to a substrate provide color by a process that alters, at least temporarily, any crystal structure of the colored substances. Such substances with considerable coloring capacity are widely employed in the textile, pharmaceutical, food, cosmetics, plastics, photographic and paper industries (3). The dyes can adhere to compatible surfaces by solution, by forming covalent bond or complexes with salts or metals, by physical adsorption or by mechanical retention. Dyes are classified according to their application and chemical structure and are composed of a group of atoms known as chromophores, responsible for the dye color. These chromophore-containing centers are based on diverse functional groups, such as azo, anthraquinone, methane, nitro, arilmethane, carbonyl and others. In addition, electrons withdrawing or donating substituents to generate or intensify the color of the chromophores are denominated as auxochromes. The most common auxochromes are amine, carboxyl, sulfonate and hydroxyl (4,5).

The textile industry consumes a substantial amount of water in its manufacturing processes used mainly in the dyeing and finishing operations of the plants. The wastewater from textile plants is classified as the most polluting of all the industrial sectors, considering the volume generated as well as the effluent composition. In addition, the increased demand for textile products and the proportional increase in their production, and the use of synthetic dyes have together contributed to dye wastewater becoming one of the substantial sources of severe pollution problems in current times.

1.2 Objectives

The objective of this research study is to determine the efficiency of different low-cost adsorbents for the treatment of milk-processing effluents and dye wastewater. Transmittance and absorbance values measured for the wastewater before and after treating with the adsorbents are discussed. Finally, suggestions for future research are made.

CHAPTER II

LITERATURE REVIEW

2.1 Dyes

Dyes are organic compounds which are widely used for imparting color to textiles. They are produced either chemically or from plants. An interesting point about them is that unlike paint, they do not build up on the surface of the fiber but are absorbed into the pores of the material. This becomes possible because of two reasons. First, the size of the dye molecules is smaller than the size of the pores in the fiber. The dye molecules have a shape like narrow strips of paper, that is having length and breadth but relatively little thickness (6,7). This planar shape assists them to slip into the polymer system when the fiber, yarn or fabric is introduced into the dye bath.

The second reason is the affinity of the dye to the fiber due to forces of attraction. The dye which has diffused or penetrated the fiber is held there by the forces of attraction between the dye and the fiber.

Up to the middle of nineteenth century, the dyestuffs used for textiles were obtained from natural sources like vegetable, animal, and mineral sources. As these dyes were not simple water-soluble substances, complex procedures were used to give rich and fast colors.

To select the proper dye for a fiber, it is necessary to know which dyes have an affinity for the vegetable, animal, or manmade fibers (8). In general, the dyes used for cotton and linen may be used for viscose rayon, but other fibers having different chemical structures require different dyes.

Direct dyes are the easiest to produce, the simplest to apply, and the cheapest in their initial cost as well as in application. They, however, like other dyes have their own limitations. One of these is the degree of color fastness.

Fastness of color refers to its ability to remain unchanged. Different dyes of assorted colors. have different degrees of fastness to various conditions. For example, a color that may have good fastness to washing may have poor fastness to light. Also, certain dyes may bleed, or run, when wet and may cause discoloration of other fabrics. Some dyes may crack, or rub off, due to frictional wear (9).

Once a color has been selected, it is essential that its formulation should be kept consistent. Each batch that is dyed must have its lot number. Since variation can occur in such factors as chemical concentration, fiber structure, and water content or temperature, any of these can cause a slight change in color thus rendering each dye lot to be slightly different.

2.2 Classification of Dyes

Dyes, as stated earlier, can be obtained from natural sources such as vegetable matter, mineral or insects or are manufactured in the factory from petrochemical feedstock. It may, however, be recalled that the first synthetic dye (Mauveine) by Perkin was made from Coal tar.

Amongst natural dyes, indigo is well known for its brilliant blue color and was obtained by fermenting the leaves of a plant. The red colored lac dye is extracted from lac, a resinous protective secretion of a tiny insect (10, 11).

The production of natural dyes and their use are both complex. So, it is no wonder that synthetic dyes have gradually superseded them. For example, indigo was synthesized in 1880 and the king of natural dyes gradually went into oblivion. With environmental concerns that earmark the present age, there are some signs of the revival of natural dyes.

Amongst the dyes that originate from minerals, iron oxide powder gives a brown color and buff derived from ferrous sulfate has also been used for coloring fibers. Biodegradation of dyes was discussed (12).

2.2.1 Water Soluble Dyes

Direct Dyes: Direct dyes are cheap and easy to apply, but of poor fastness quality. These dyes are also known as 'salt dyes' or cotton colors, which dye cotton, other vegetable fibers and viscose rayon. They are readily soluble in water. Colors of cotton fabrics dyed with direct dyes are not fast. They are applied to Cellulose fibers from aqueous liquor in which an electrolyte is added, which is usually Sodium Chloride as it accelerates the rate at which the dye is picked up by the fiber. They generally bleed. To make them fast on fabric add Sodium Bicarbonate for warm colors, and Copper Sulfate for cool colors (13).

Acid Dyes: These are soluble in water and are applied under acidic conditions. The acid dyestuff is mostly used for wool and silk and to a less extent nylon and acrylic fibers. The maximum quantity of dye absorbed depends on the amount of H2SO4 present in the bath. Acid dyes are inexpensive dyes. They are fast to light, but they are not fast to washing.

Basic Dyes: The first coal tar dye was a basic dye. It is applied to wool, silk, cotton, acrylic, and modacrylic fibers. When acrylic fibers were first marketed, they were very difficult to dye due to lack of specific dye sites in the fibers. Such groups were introduced into the fiber and brilliant colors can now be obtained with these dyes. They give good fastness and bright shades to acrylics.

Reactive Dyes: They were first developed in 1956 by I.C.I., U.K. The dye is retained by means of a chemical reaction between the dye and the fiber. As such their fastness properties are excellent. The fibers most readily colored with reactive dyes are natural and manmade cellulosic fibers, natural protein fibers and polyamide fibers. With some reactive dyes, the dyeing can be carried out at room temperature. However, with most reactive dyes, the dyeing is carried out at elevated temperatures (up to the boil) (14).

2.2.2 Water In-Soluble Dyes

Vat Dyes: They are insoluble in water, but they are made soluble using a strong reducing agent, such as Sodium hydrosphere dissolved in sodium hydroxide. These are the fastest dyes for cotton, linen, and rayon (15,16). They also may be applied to wool, nylon, polyester etc. Vat dyes are hot water dyes. Hot water dyes are available in both powder and liquid form. The first synthetic Vat dye was an Indigo created in 1879. Vat dyes are expensive because of the initial cost as well as the method of application.

Disperse Dyes: The fibers that are most commonly dyed with disperse dyes are cellulose diacetate, cellulose triacetate and polyester fibers. To a lesser extent acrylic and nylon fibers are also dyed with disperse dyes. Polyester fibers being hydrophobic and with significant crystalline content, the assistance of elevated temperature, high pressure and carriers (which swell the fiber) is taken to achieve satisfactory dyeing.

Sulphur Dyes*:* Natural and manmade cellulosic fibers are readily dyed with Sulphur dyes. Water soluble or leucon form of the dye is produced through reduction of the dye with Sodium Sulfide or Sodium Hydrosphere. The dye liquor is heated to obtain satisfactory rate of dyeing. Once the dye is within the fiber, the reduced Sulphur dye is converted to its original insoluble form by oxidation with an oxidizing agent like Sodium perborate.

2.2.3 In-situ Color Formation

Azoic Colors: The Azoic colors are applied to cotton in two stages. The first consists of treatment with naphthol and the second by treatment of the naphtholate material with diazotized base or diazotized salt. The color development takes place in-situ by the coupling reaction between naphthol and diazo component. They are quite fast to washing and have poor to excellent light fastness (17, 18). Azoic colors are used mostly on cotton and for special purposes on nylon. Azoic colors are sometimes referred to as ice dyes because ice is frequently used to bring the dyes to low temperatures. Azoic colors give bright, high intensity colors, much more so than the common dye classes. These are cold water dyes and are most suitable for cold dyeing techniques such as Batik, Tie-Dye, etc.

2.3 Dairy Wastewater

Dairy industries are involved in the manufacturing of several types of milk products such as fluid milk, butter, cheese, yogurt, condensed milk, flavored milk, milk powder, ice cream, etc. Typical by-products obtained include buttermilk, whey, and their derivatives. A chain of operations involving receiving and storing of raw materials, processing of raw materials into finished products, packaging and storing of finished products, and a group of other ancillary operations (e.g., heat transfer and cleaning) are examples of some of the vast variety of operations performed in the dairy industries (19). The initial operations such as homogenization, standardization, clarification, separation, and pasteurization are common to most plants and products. Clarification (removal of suspended matter) and separation (removal of cream for milk standardization to desired butterfat content), generally, are accomplished by specially designed large centrifuges. Drying, condensing, etc. are also used in dairy industries to produce various products. In the dairy industry, some amount of wastewater gets produced during starting, equilibrating, stopping, and rinsing of the processing units (flushing water, first rinse water, etc.). However, a majority of wastewater gets produced during cleaning operations, especially between product changes when diverse types of products are produced in a specific production unit and clean-up operations (20). The dairy industry is one of the most polluting of industries, not only in terms of the volume of effluent generated, but also in terms of its characteristics as well. It generates about 0.2–10 liters of effluent per liter of processed milk with an average generation of about 2.5 liters of wastewater per liter of the milk processed. Dairy processing effluents are generated in an intermittent way and the flow rates of these effluents change significantly. Also, the quality and quantity of the product content in the dairy wastewater at a given time changes with the application of another technological cycle in the processing line (22,23). Moreover, because the dairy industry produces assorted products, such as milk, butter, yogurt, ice-cream, and several types of desserts and cheese, the characteristics of these effluents also vary widely both in quantity and quality, depending on the type of system and the methods of operation used.

Dairy effluent contains soluble organics, suspended solids, trace organics. All these components contribute largely towards their high biological oxygen demand (BODS) and chemical oxygen demand (COD). The characteristics of a dairy effluent contain Temperature, Color, PH (6.5-8.0), DO, BOD, COD, Dissolved solids suspended solids, chlorides sulfate, oil & grease (24). The wastewater of dairy contains copious quantities of milk constituents such as casein, inorganic salts, besides detergents and sanitizers used for washing. It has high sodium content from the use of caustic soda for cleaning.

2.4 Dye Wastewater

Wastewater derived from the production of dyes is highly variable in composition and contains many different compounds such as raw materials (anilines), intermediate products, and even the dye itself. As with many other industrial sectors, growing concern about environmental issues has prompted the dye manufacture industry and textile industry to investigate more appropriate and environmentally friendly treatment technologies to meet the discharge restraints that are becoming stricter every day (25, 26). Dyes production, textile preparation, dyeing and finishing plants are currently being forced to treat their effluents at least partially prior to discharge to publicly owned treatment works because of the high organic load, strong and resistant colour as well as high dissolved solids content of the discharged wastewater. Conventional treatments of wastewater containing organic compounds include biological oxidation, chemical coagulation, advanced oxidation and adsorption. Biological methods are generally cheap and simple to apply and are currently used to remove organics and color from dyeing and textile wastewater (27). However, this dyeing wastewater cannot be readily degraded by conventional biological processes, e.g., the activated sludge process, because the structures of most commercial dye compounds are generally very complex, and many dyes are non-biodegradable due to their chemical nature, molecular size; thus, this results in sludge bulking. Although dyestuffs and color materials in wastewater can be effectively destroyed by wet oxidation, advanced chemical oxidation such as H2O2/UV, O3, and adsorption using activated carbon, the costs of these methods are relatively high.

Presently, wastewater from dye manufacturing industry is usually treated by combination process of biological treatment and coagulation treatment, before being fed to the biological treatment units, coagulation can reduce the wastewater loading and thus reduce the treatment cost. Inorganic polymer flocculants (IPFs) are a new kind of water and wastewater treatment reagents, which have been developed worldwide since the 1960s. Because of their superior efficiency and relatively lower cost compared with traditional coagulants such as aluminum or iron salts, IPFs are becoming the main water and wastewater treatment reagents, with production and applications on a large scale in Japan, Russia, West Europe and China presently (28). The USA has also paid much attention to it in recent years. In this study, adsorption was used to remove the colored compounds present in wastewater from dye manufacturing industry combined with dairy wastewater.

2.5 Absorbance

Absorbance is the capacity of the substance to absorb a light falling on its surface. A general example will give a better know about the concept of transmittance, in hotter regions the houses are painted in light colors like sky blue, white and peach, whereas the dark colors are strongly avoided, that is because the dark colors absorb more of the sunlight falling and gets hotter than any light color. Absorbance is equal to the logarithm of the reciprocal of the transmittance. This can be further elaborated as when all the light hitting the surface of the object is absorbed then the transmittance is 0% and the absorption is 100%. Therefore, it can be said that both these concepts are exactly opposite to each other. No manual equipment can tell about the actual absorbance value of an object as it is quite low, to get an accurate measurement of the absorption quantity, laser-based techniques are considered one of the most accurate. The method through which absorption is being measured is called absorption spectroscopy (29). When the absorbance of the object is to be measured using spectrophotometer, absorbance can be defined as Log-10 (I0/I), where I0 is the intensity of the incident light ray, and I is the intensity of transmitted light.

2.6 Transmittance

The term transmittance holds concepts in various fields like physics, analytical chemistry, and others. Transmittance is the ratio of light passing through the surface of the object, when it is denoted in percentage with respect to the total intensity of light, then it is called percentage transmittance. Transmittance is the ratio between the Intensity of transmitted light I and the intensity of incident light I0. More the light passing through the object, more the transmittance, less the light passing through the object, less the transmittance. Unlike absorbance, transmittance can also be measured using the normal equipment.

2.7 Absorbance vs. Transmittance

Absorbance is the capacity of the substance to absorb a light falling on its surface, whereas, transmittance is the ratio of light passing through the surface of the object.

When all the light hitting the surface of the object is absorbed then the transmittance is 0% and the absorption is 100%, on the other hand, if all the light hitting the surface of an object passes through the object then transmittance is 100% and absorption will be 0%.

Absorbance gives the percentage in accordance with the light being absorbed with respect to the total intensity of light falling on the object, whereas transmittance gives the percentage in accordance with total light passing through the object surface with respect to the total intensity of light falling on object.

The value of absorption is relatively low as compare to the transmittance. Generally, absorption always have a lower value than 1.

Absorption is a lesser value and requires laser and other such technologies for measurement, on the other hand, transmittance can easily be measured using the physical equipment.

2.8 Adsorption

Adsorption is a mass transfer process which involves the accumulation of substances at the interface of two phases, such as, liquid–liquid, gas–liquid, gas–solid or liquid–solid interface. The substance being adsorbed is the adsorbate and the adsorbing material is termed the adsorbent. The properties of adsorbates and adsorbents are quite specific and depend upon their constituents. If the interaction between the solid surface and the adsorbed molecules has a physical nature, the process is called physisorption. In this case, the attraction interactions are van der Waals forces and, as they are weak the process results are reversible (30). Furthermore, it occurs lower or close to the critical temperature of the adsorbed substance. On the other hand, if the attraction forces between adsorbed molecules and the solid surface are due to chemical bonding, the adsorption process is called chemisorption. Contrary to physisorption, chemisorption occurs only as a monolayer and, furthermore, substances chemisorbed on solid surface are hardly removed because of stronger forces at stake. Under favorable conditions, both processes can occur simultaneously or alternatively. Physical adsorption is accompanied by a decrease in free energy and entropy of the adsorption system and, thereby, this process is exothermic.

In a solid–liquid system adsorption results in the removal of solutes from solution and their accumulation at solid surface. The solute remaining in the solution reaches a dynamic equilibrium with that adsorbed on the solid phase. The amount of adsorbate that can be taken up by an adsorbent as a function of both temperature and concentration of adsorbate, and the process, at constant temperature, can be described by an adsorption isotherm.

2.9 Micro Filtration

Micro filtration is a separation technique for removing micron-sized particles, like bacteria, yeast cells, colloids, and smoke particles, from suspensions or gases. The process uses membrane filters with pores in the approximate size range 0.1 to 10 μm, which are permeable to the Sued, but retain the particles, thus causing separation.

Two main types of membrane Filters exist: screen Filters and depth Filters. Screen Filters contain capillary-type pores; particles are retained on the membrane surface primarily by a sieving mechanism. Depth Filters contain a random, tortuous porous structure; particles are retained through adsorption and mechanical entrapment within the bulk of the filter. Screen Filters are absolute: particles larger than the pore size are retained, whereas particles smaller than the pore size can pass relatively easily through the membrane. Particle retention of depth Filters is not that clearly drained: retention values increase slowly over a broad particle size range and only reach 100% for very large particles. Depth Filters are often used for dead-end filtration, as they can retain a high particle load.

Chapter III

MATERIALS AND METHODS

3.1 Dyes

The following dyes were used in the experiment

1. Rhodamine 6 G (MW= 479.01)

2. Acid Yellow (MW= 380.36)

3. Orange pure- II (MW= 350.32)

3.2 Adsorbents & Materials

3.2.1 Adsorbents

The following adsorbents were used to study the color removal using adsorption with the dyes mentioned above

1. Activated Carbon (DARCO, Powdered Activated Carbon, Grade: HDC)
2. Peanut Hull
3. Banana Peel

3.2.2 Materials

The following material is used to develop the dairy wastewater to mix with dye wastewater

1. Milk powder

3.3 Equipment

1. Weighing balance (Mettler Toledo)
2. Spectrophotometer (Genesis 20)
3. Shaker, 115 V 60 CV AC
4. TOC analyzer (Shimadzu TOC-L)
5. Oven
6. Whatman 41 Filter Papers

3.4 Run Protocols

Table 1 to Table 36 are the run protocols for this research. The parameters that are varied in the research are for three different dyes concentration of dye and concentration of milk wastewater, type of adsorbent and dosage of adsorbent.

Table 1: Run protocol of Rhodamine 6 G (20 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	20	50	0.25				
2	20	50	0.5				
3	20	50	0.75				
4	20	50	1				
5	20	50	1.25				
6	20	100	0.25				
7	20	100	0.5				
8	20	100	0.75				
9	20	100	1				
10	20	100	1.25				
11	20	150	0.25				
12	20	150	0.5				
13	20	150	0.75				
14	20	150	1				
15	20	150	1.25				
16	20	200	0.25				
17	20	200	0.5				
18	20	200	0.75				
19	20	200	1				
20	20	200	1.25				
21	20	250	0.25				
22	20	250	0.5				
23	20	250	0.75				
24	20	250	1				
25	20	250	1.25				

Table 2: Run protocol of Rhodamine 6 G (20 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	20	50	3.327-2.380				
2	20	50	2.380-2.362				
3	20	50	2.362-0.600				
4	20	50	0.600-0.425				
5	20	50	<0.425				
6	20	100	3.327-2.380				
7	20	100	2.380-2.362				
8	20	100	2.362-0.600				
9	20	100	0.600-0.425				
10	20	100	<0.425				
11	20	150	3.327-2.380				
12	20	150	2.380-2.362				
13	20	150	2.362-0.600				
14	20	150	0.600-0.425				
15	20	150	<0.425				
16	20	200	3.327-2.380				
17	20	200	2.380-2.362				
18	20	200	2.362-0.600				
19	20	200	0.600-0.425				
20	20	200	<0.425				
21	20	250	3.327-2.380				
22	20	250	2.380-2.362				
23	20	250	2.362-0.600				
24	20	250	0.600-0.425				
25	20	250	<0.425				

Table 3: Run protocol of Rhodamine 6 G (20 ppm) - Banana Peel

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	20	50	0.25				
2	20	50	0.5				
3	20	50	0.75				
4	20	50	1				
5	20	50	1.25				
6	20	100	0.25				
7	20	100	0.5				
8	20	100	0.75				
9	20	100	1				
10	20	100	1.25				
11	20	150	0.25				
12	20	150	0.5				
13	20	150	0.75				
14	20	150	1				
15	20	150	1.25				
16	20	200	0.25				
17	20	200	0.5				
18	20	200	0.75				
19	20	200	1				
20	20	200	1.25				
21	20	250	0.25				
22	20	250	0.5				
23	20	250	0.75				
24	20	250	1				
25	20	250	1.25				

Table 4: Run protocol of Rhodamine 6 G (40 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	40	50	0.25				
2	40	50	0.5				
3	40	50	0.75				
4	40	50	1				
5	40	50	1.25				
6	40	100	0.25				
7	40	100	0.5				
8	40	100	0.75				
9	40	100	1				
10	40	100	1.25				
11	40	150	0.25				
12	40	150	0.5				
13	40	150	0.75				
14	40	150	1				
15	40	150	1.25				
16	40	200	0.25				
17	40	200	0.5				
18	40	200	0.75				
19	40	200	1				
20	40	200	1.25				
21	40	250	0.25				
22	40	250	0.5				
23	40	250	0.75				
24	40	250	1				
25	40	250	1.25				

Table 5: Run protocol of Rhodamine 6 G (40 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	40	50	3.327-2.380				
2	40	50	2.380-2.362				
3	40	50	2.362-0.600				
4	40	50	0.600-0.425				
5	40	50	<0.425				
6	40	100	3.327-2.380				
7	40	100	2.380-2.362				
8	40	100	2.362-0.600				
9	40	100	0.600-0.425				
10	40	100	<0.425				
11	40	150	3.327-2.380				
12	40	150	2.380-2.362				
13	40	150	2.362-0.600				
14	40	150	0.600-0.425				
15	40	150	<0.425				
16	40	200	3.327-2.380				
17	40	200	2.380-2.362				
18	40	200	2.362-0.600				
19	40	200	0.600-0.425				
20	40	200	<0.425				
21	40	250	3.327-2.380				
22	40	250	2.380-2.362				
23	40	250	2.362-0.600				
24	40	250	0.600-0.425				
25	40	250	<0.425				

Table 6: Run protocol of Rhodamine 6 G (40 ppm) - Banana Peel

S.No	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	40	50	0.25				
2	40	50	0.5				
3	40	50	0.75				
4	40	50	1				
5	40	50	1.25				
6	40	100	0.25				
7	40	100	0.5				
8	40	100	0.75				
9	40	100	1				
10	40	100	1.25				
11	40	150	0.25				
12	40	150	0.5				
13	40	150	0.75				
14	40	150	1				
15	40	150	1.25				
16	40	200	0.25				
17	40	200	0.5				
18	40	200	0.75				
19	40	200	1				
20	40	200	1.25				
21	40	250	0.25				
22	40	250	0.5				
23	40	250	0.75				
24	40	250	1				
25	40	250	1.25				

Table 7: Run protocol of Rhodamine 6 G (60 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	60	50	0.25				
2	60	50	0.5				
3	60	50	0.75				
4	60	50	1				
5	60	50	1.25				
6	60	100	0.25				
7	60	100	0.5				
8	60	100	0.75				
9	60	100	1				
10	60	100	1.25				
11	60	150	0.25				
12	60	150	0.5				
13	60	150	0.75				
14	60	150	1				
15	60	150	1.25				
16	60	200	0.25				
17	60	200	0.5				
18	60	200	0.75				
19	60	200	1				
20	60	200	1.25				
21	60	250	0.25				
22	60	250	0.5				
23	60	250	0.75				
24	60	250	1				
25	60	250	1.25				

Table 8: Run protocol of Rhodamine 6 G (60 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	60	50	3.327-2.380				
2	60	50	2.380-2.362				
3	60	50	2.362-0.600				
4	60	50	0.600-0.425				
5	60	50	<0.425				
6	60	100	3.327-2.380				
7	60	100	2.380-2.362				
8	60	100	2.362-0.600				
9	60	100	0.600-0.425				
10	60	100	<0.425				
11	60	150	3.327-2.380				
12	60	150	2.380-2.362				
13	60	150	2.362-0.600				
14	60	150	0.600-0.425				
15	60	150	<0.425				
16	60	200	3.327-2.380				
17	60	200	2.380-2.362				
18	60	200	2.362-0.600				
19	60	200	0.600-0.425				
20	60	200	<0.425				
21	60	250	3.327-2.380				
22	60	250	2.380-2.362				
23	60	250	2.362-0.600				
24	60	250	0.600-0.425				
25	60	250	<0.425				

Table 9: Run protocol of Rhodamine 6 G (60 ppm) - Banana Peel

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	60	50	0.25				
2	60	50	0.5				
3	60	50	0.75				
4	60	50	1				
5	60	50	1.25				
6	60	100	0.25				
7	60	100	0.5				
8	60	100	0.75				
9	60	100	1				
10	60	100	1.25				
11	60	150	0.25				
12	60	150	0.5				
13	60	150	0.75				
14	60	150	1				
15	60	150	1.25				
16	60	200	0.25				
17	60	200	0.5				
18	60	200	0.75				
19	60	200	1				
20	60	200	1.25				
21	60	250	0.25				
22	60	250	0.5				
23	60	250	0.75				
24	60	250	1				
25	60	250	1.25				

Table 10: Run protocol of Rhodamine 6 G (80 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	80	50	0.25				
2	80	50	0.5				
3	80	50	0.75				
4	80	50	1				
5	80	50	1.25				
6	80	100	0.25				
7	80	100	0.5				
8	80	100	0.75				
9	80	100	1				
10	80	100	1.25				
11	80	150	0.25				
12	80	150	0.5				
13	80	150	0.75				
14	80	150	1				
15	80	150	1.25				
16	80	200	0.25				
17	80	200	0.5				
18	80	200	0.75				
19	80	200	1				
20	80	200	1.25				
21	80	250	0.25				
22	80	250	0.5				
23	80	250	0.75				
24	80	250	1				
25	80	250	1.25				

Table 11: Run protocol of Rhodamine 6 G (80 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	80	50	3.327-2.380				
2	80	50	2.380-2.362				
3	80	50	2.362-0.600				
4	80	50	0.600-0.425				
5	80	50	<0.425				
6	80	100	3.327-2.380				
7	80	100	2.380-2.362				
8	80	100	2.362-0.600				
9	80	100	0.600-0.425				
10	80	100	<0.425				
11	80	150	3.327-2.380				
12	80	150	2.380-2.362				
13	80	150	2.362-0.600				
14	80	150	0.600-0.425				
15	80	150	<0.425				
16	80	200	3.327-2.380				
17	80	200	2.380-2.362				
18	80	200	2.362-0.600				
19	80	200	0.600-0.425				
20	80	200	<0.425				
21	80	250	3.327-2.380				
22	80	250	2.380-2.362				
23	80	250	2.362-0.600				
24	80	250	0.600-0.425				
25	80	250	<0.425				

Table 12: Run protocol of Rhodamine 6 G (80 ppm) - Banana Peel

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	80	50	0.25				
2	80	50	0.5				
3	80	50	0.75				
4	80	50	1				
5	80	50	1.25				
6	80	100	0.25				
7	80	100	0.5				
8	80	100	0.75				
9	80	100	1				
10	80	100	1.25				
11	80	150	0.25				
12	80	150	0.5				
13	80	150	0.75				
14	80	150	1				
15	80	150	1.25				
16	80	200	0.25				
17	80	200	0.5				
18	80	200	0.75				
19	80	200	1				
20	80	200	1.25				
21	80	250	0.25				
22	80	250	0.5				
23	80	250	0.75				
24	80	250	1				
25	80	250	1.25				

Table 13: Run protocol of Acid Yellow (25 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	25	50	0.25				
2	25	50	0.5				
3	25	50	0.75				
4	25	50	1				
5	25	50	1.25				
6	25	100	0.25				
7	25	100	0.5				
8	25	100	0.75				
9	25	100	1				
10	25	100	1.25				
11	25	150	0.25				
12	25	150	0.5				
13	25	150	0.75				
14	25	150	1				
15	25	150	1.25				
16	25	200	0.25				
17	25	200	0.5				
18	25	200	0.75				
19	25	200	1				
20	25	200	1.25				
21	25	250	0.25				
22	25	250	0.5				
23	25	250	0.75				
24	25	250	1				
25	25	250	1.25				

Table 14: Run protocol of Acid Yellow (25 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	25	50	3.327-2.380				
2	25	50	2.380-2.362				
3	25	50	2.362-0.600				
4	25	50	0.600-0.425				
5	25	50	<0.425				
6	25	100	3.327-2.380				
7	25	100	2.380-2.362				
8	25	100	2.362-0.600				
9	25	100	0.600-0.425				
10	25	100	<0.425				
11	25	150	3.327-2.380				
12	25	150	2.380-2.362				
13	25	150	2.362-0.600				
14	25	150	0.600-0.425				
15	25	150	<0.425				
16	25	200	3.327-2.380				
17	25	200	2.380-2.362				
18	25	200	2.362-0.600				
19	25	200	0.600-0.425				
20	25	200	<0.425				
21	25	250	3.327-2.380				
22	25	250	2.380-2.362				
23	25	250	2.362-0.600				
24	25	250	0.600-0.425				
25	25	250	<0.425				

Table 15: Run protocol of Acid Yellow (25 ppm) - Banana Peel

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	25	50	0.25				
2	25	50	0.5				
3	25	50	0.75				
4	25	50	1				
5	25	50	1.25				
6	25	100	0.25				
7	25	100	0.5				
8	25	100	0.75				
9	25	100	1				
10	25	100	1.25				
11	25	150	0.25				
12	25	150	0.5				
13	25	150	0.75				
14	25	150	1				
15	25	150	1.25				
16	25	200	0.25				
17	25	200	0.5				
18	25	200	0.75				
19	25	200	1				
20	25	200	1.25				
21	25	250	0.25				
22	25	250	0.5				
23	25	250	0.75				
24	25	250	1				
25	25	250	1.25				

Table 16: Run protocol of Acid Yellow (50 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	50	50	0.25				
2	50	50	0.5				
3	50	50	0.75				
4	50	50	1				
5	50	50	1.25				
6	50	100	0.25				
7	50	100	0.5				
8	50	100	0.75				
9	50	100	1				
10	50	100	1.25				
11	50	150	0.25				
12	50	150	0.5				
13	50	150	0.75				
14	50	150	1				
15	50	150	1.25				
16	50	200	0.25				
17	50	200	0.5				
18	50	200	0.75				
19	50	200	1				
20	50	200	1.25				
21	50	250	0.25				
22	50	250	0.5				
23	50	250	0.75				
24	50	250	1				
25	50	250	1.25				

Table 17: Run protocol of Acid Yellow (50 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	50	50	3.327-2.380				
2	50	50	2.380-2.362				
3	50	50	2.362-0.600				
4	50	50	0.600-0.425				
5	50	50	<0.425				
6	50	100	3.327-2.380				
7	50	100	2.380-2.362				
8	50	100	2.362-0.600				
9	50	100	0.600-0.425				
10	50	100	<0.425				
11	50	150	3.327-2.380				
12	50	150	2.380-2.362				
13	50	150	2.362-0.600				
14	50	150	0.600-0.425				
15	50	150	<0.425				
16	50	200	3.327-2.380				
17	50	200	2.380-2.362				
18	50	200	2.362-0.600				
19	50	200	0.600-0.425				
20	50	200	<0.425				
21	50	250	3.327-2.380				
22	50	250	2.380-2.362				
23	50	250	2.362-0.600				
24	50	250	0.600-0.425				
25	50	250	<0.425				

Table 18: Run protocol of Acid Yellow (50 ppm) - Banana Peel

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	50	50	0.25				
2	50	50	0.5				
3	50	50	0.75				
4	50	50	1				
5	50	50	1.25				
6	50	100	0.25				
7	50	100	0.5				
8	50	100	0.75				
9	50	100	1				
10	50	100	1.25				
11	50	150	0.25				
12	50	150	0.5				
13	50	150	0.75				
14	50	150	1				
15	50	150	1.25				
16	50	200	0.25				
17	50	200	0.5				
18	50	200	0.75				
19	50	200	1				
20	50	200	1.25				
21	50	250	0.25				
22	50	250	0.5				
23	50	250	0.75				
24	50	250	1				
25	50	250	1.25				

Table 19: Run protocol of Acid Yellow (75 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	75	50	0.25				
2	75	50	0.5				
3	75	50	0.75				
4	75	50	1				
5	75	50	1.25				
6	75	100	0.25				
7	75	100	0.5				
8	75	100	0.75				
9	75	100	1				
10	75	100	1.25				
11	75	150	0.25				
12	75	150	0.5				
13	75	150	0.75				
14	75	150	1				
15	75	150	1.25				
16	75	200	0.25				
17	75	200	0.5				
18	75	200	0.75				
19	75	200	1				
20	75	200	1.25				
21	75	250	0.25				
22	75	250	0.5				
23	75	250	0.75				
24	75	250	1				
25	75	250	1.25				

Table 20: Run protocol of Acid Yellow (75 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	75	50	3.327-2.380				
2	75	50	2.380-2.362				
3	75	50	2.362-0.600				
4	75	50	0.600-0.425				
5	75	50	<0.425				
6	75	100	3.327-2.380				
7	75	100	2.380-2.362				
8	75	100	2.362-0.600				
9	75	100	0.600-0.425				
10	75	100	<0.425				
11	75	150	3.327-2.380				
12	75	150	2.380-2.362				
13	75	150	2.362-0.600				
14	75	150	0.600-0.425				
15	75	150	<0.425				
16	75	200	3.327-2.380				
17	75	200	2.380-2.362				
18	75	200	2.362-0.600				
19	75	200	0.600-0.425				
20	75	200	<0.425				
21	75	250	3.327-2.380				
22	75	250	2.380-2.362				
23	75	250	2.362-0.600				
24	75	250	0.600-0.425				
25	75	250	<0.425				

Table 21: Run protocol of Acid Yellow (75 ppm) - Banana Peel

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	75	50	0.25				
2	75	50	0.5				
3	75	50	0.75				
4	75	50	1				
5	75	50	1.25				
6	75	100	0.25				
7	75	100	0.5				
8	75	100	0.75				
9	75	100	1				
10	75	100	1.25				
11	75	150	0.25				
12	75	150	0.5				
13	75	150	0.75				
14	75	150	1				
15	75	150	1.25				
16	75	200	0.25				
17	75	200	0.5				
18	75	200	0.75				
19	75	200	1				
20	75	200	1.25				
21	75	250	0.25				
22	75	250	0.5				
23	75	250	0.75				
24	75	250	1				
25	75	250	1.25				

Table 22: Run protocol of Acid Yellow (100 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	100	50	0.25				
2	100	50	0.5				
3	100	50	0.75				
4	100	50	1				
5	100	50	1.25				
6	100	100	0.25				
7	100	100	0.5				
8	100	100	0.75				
9	100	100	1				
10	100	100	1.25				
11	100	150	0.25				
12	100	150	0.5				
13	100	150	0.75				
14	100	150	1				
15	100	150	1.25				
16	100	200	0.25				
17	100	200	0.5				
18	100	200	0.75				
19	100	200	1				
20	100	200	1.25				
21	100	250	0.25				
22	100	250	0.5				
23	100	250	0.75				
24	100	250	1				
25	100	250	1.25				

Table 23: Run protocol of Acid Yellow (100 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	100	50	3.327-2.380				
2	100	50	2.380-2.362				
3	100	50	2.362-0.600				
4	100	50	0.600-0.425				
5	100	50	<0.425				
6	100	100	3.327-2.380				
7	100	100	2.380-2.362				
8	100	100	2.362-0.600				
9	100	100	0.600-0.425				
10	100	100	<0.425				
11	100	150	3.327-2.380				
12	100	150	2.380-2.362				
13	100	150	2.362-0.600				
14	100	150	0.600-0.425				
15	100	150	<0.425				
16	100	200	3.327-2.380				
17	100	200	2.380-2.362				
18	100	200	2.362-0.600				
19	100	200	0.600-0.425				
20	100	200	<0.425				
21	100	250	3.327-2.380				
22	100	250	2.380-2.362				
23	100	250	2.362-0.600				
24	100	250	0.600-0.425				
25	100	250	<0.425				

Table 24: Run protocol of Acid Yellow (100 ppm) - Banana Peel

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	100	50	0.25				
2	100	50	0.5				
3	100	50	0.75				
4	100	50	1				
5	100	50	1.25				
6	100	100	0.25				
7	100	100	0.5				
8	100	100	0.75				
9	100	100	1				
10	100	100	1.25				
11	100	150	0.25				
12	100	150	0.5				
13	100	150	0.75				
14	100	150	1				
15	100	150	1.25				
16	100	200	0.25				
17	100	200	0.5				
18	100	200	0.75				
19	100	200	1				
20	100	200	1.25				
21	100	250	0.25				
22	100	250	0.5				
23	100	250	0.75				
24	100	250	1				
25	100	250	1.25				

Table 25: Run protocol of Orange Pure II (50 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	50	50	0.25				
2	50	50	0.5				
3	50	50	0.75				
4	50	50	1				
5	50	50	1.25				
6	50	100	0.25				
7	50	100	0.5				
8	50	100	0.75				
9	50	100	1				
10	50	100	1.25				
11	50	150	0.25				
12	50	150	0.5				
13	50	150	0.75				
14	50	150	1				
15	50	150	1.25				
16	50	200	0.25				
17	50	200	0.5				
18	50	200	0.75				
19	50	200	1				
20	50	200	1.25				
21	50	250	0.25				
22	50	250	0.5				
23	50	250	0.75				
24	50	250	1				
25	50	250	1.25				

Table 26: Run protocol of Orange Pure II (50 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	50	50	3.327-2.380				
2	50	50	2.380-2.362				
3	50	50	2.362-0.600				
4	50	50	0.600-0.425				
5	50	50	<0.425				
6	50	100	3.327-2.380				
7	50	100	2.380-2.362				
8	50	100	2.362-0.600				
9	50	100	0.600-0.425				
10	50	100	<0.425				
11	50	150	3.327-2.380				
12	50	150	2.380-2.362				
13	50	150	2.362-0.600				
14	50	150	0.600-0.425				
15	50	150	<0.425				
16	50	200	3.327-2.380				
17	50	200	2.380-2.362				
18	50	200	2.362-0.600				
19	50	200	0.600-0.425				
20	50	200	<0.425				
21	50	250	3.327-2.380				
22	50	250	2.380-2.362				
23	50	250	2.362-0.600				
24	50	250	0.600-0.425				
25	50	250	<0.425				

Table 27: Run protocol of Orange Pure II (50 ppm) - Banana Peel

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	50	50	0.25				
2	50	50	0.5				
3	50	50	0.75				
4	50	50	1				
5	50	50	1.25				
6	50	100	0.25				
7	50	100	0.5				
8	50	100	0.75				
9	50	100	1				
10	50	100	1.25				
11	50	150	0.25				
12	50	150	0.5				
13	50	150	0.75				
14	50	150	1				
15	50	150	1.25				
16	50	200	0.25				
17	50	200	0.5				
18	50	200	0.75				
19	50	200	1				
20	50	200	1.25				
21	50	250	0.25				
22	50	250	0.5				
23	50	250	0.75				
24	50	250	1				
25	50	250	1.25				

Table 28: Run protocol of Orange Pure II (100 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	100	50	0.25				
2	100	50	0.5				
3	100	50	0.75				
4	100	50	1				
5	100	50	1.25				
6	100	100	0.25				
7	100	100	0.5				
8	100	100	0.75				
9	100	100	1				
10	100	100	1.25				
11	100	150	0.25				
12	100	150	0.5				
13	100	150	0.75				
14	100	150	1				
15	100	150	1.25				
16	100	200	0.25				
17	100	200	0.5				
18	100	200	0.75				
19	100	200	1				
20	100	200	1.25				
21	100	250	0.25				
22	100	250	0.5				
23	100	250	0.75				
24	100	250	1				
25	100	250	1.25				

Table 29: Run protocol of Orange Pure II (100 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	100	50	3.327-2.380				
2	100	50	2.380-2.362				
3	100	50	2.362-0.600				
4	100	50	0.600-0.425				
5	100	50	<0.425				
6	100	100	3.327-2.380				
7	100	100	2.380-2.362				
8	100	100	2.362-0.600				
9	100	100	0.600-0.425				
10	100	100	<0.425				
11	100	150	3.327-2.380				
12	100	150	2.380-2.362				
13	100	150	2.362-0.600				
14	100	150	0.600-0.425				
15	100	150	<0.425				
16	100	200	3.327-2.380				
17	100	200	2.380-2.362				
18	100	200	2.362-0.600				
19	100	200	0.600-0.425				
20	100	200	<0.425				
21	100	250	3.327-2.380				
22	100	250	2.380-2.362				
23	100	250	2.362-0.600				
24	100	250	0.600-0.425				
25	100	250	<0.425				

Table 30: Run protocol of Orange Pure II (100 ppm) - Banana Peel

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	100	50	0.25				
2	100	50	0.5				
3	100	50	0.75				
4	100	50	1				
5	100	50	1.25				
6	100	100	0.25				
7	100	100	0.5				
8	100	100	0.75				
9	100	100	1				
10	100	100	1.25				
11	100	150	0.25				
12	100	150	0.5				
13	100	150	0.75				
14	100	150	1				
15	100	150	1.25				
16	100	200	0.25				
17	100	200	0.5				
18	100	200	0.75				
19	100	200	1				
20	100	200	1.25				
21	100	250	0.25				
22	100	250	0.5				
23	100	250	0.75				
24	100	250	1				
25	100	250	1.25				

Table 31: Run protocol of Orange Pure II (150 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	150	50	0.25				
2	150	50	0.5				
3	150	50	0.75				
4	150	50	1				
5	150	50	1.25				
6	150	100	0.25				
7	150	100	0.5				
8	150	100	0.75				
9	150	100	1				
10	150	100	1.25				
11	150	150	0.25				
12	150	150	0.5				
13	150	150	0.75				
14	150	150	1				
15	150	150	1.25				
16	150	200	0.25				
17	150	200	0.5				
18	150	200	0.75				
19	150	200	1				
20	150	200	1.25				
21	150	250	0.25				
22	150	250	0.5				
23	150	250	0.75				
24	150	250	1				
25	150	250	1.25				

Table 32: Run protocol of Orange Pure II (150 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	150	50	3.327-2.380				
2	150	50	2.380-2.362				
3	150	50	2.362-0.600				
4	150	50	0.600-0.425				
5	150	50	<0.425				
6	150	100	3.327-2.380				
7	150	100	2.380-2.362				
8	150	100	2.362-0.600				
9	150	100	0.600-0.425				
10	150	100	<0.425				
11	150	150	3.327-2.380				
12	150	150	2.380-2.362				
13	150	150	2.362-0.600				
14	150	150	0.600-0.425				
15	150	150	<0.425				
16	150	200	3.327-2.380				
17	150	200	2.380-2.362				
18	150	200	2.362-0.600				
19	150	200	0.600-0.425				
20	150	200	<0.425				
21	150	250	3.327-2.380				
22	150	250	2.380-2.362				
23	150	250	2.362-0.600				
24	150	250	0.600-0.425				
25	150	250	<0.425				

Table 33: Run protocol of Orange Pure II (150 ppm) - Banana Peel

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	150	50	0.25				
2	150	50	0.5				
3	150	50	0.75				
4	150	50	1				
5	150	50	1.25				
6	150	100	0.25				
7	150	100	0.5				
8	150	100	0.75				
9	150	100	1				
10	150	100	1.25				
11	150	150	0.25				
12	150	150	0.5				
13	150	150	0.75				
14	150	150	1				
15	150	150	1.25				
16	150	200	0.25				
17	150	200	0.5				
18	150	200	0.75				
19	150	200	1				
20	150	200	1.25				
21	150	250	0.25				
22	150	250	0.5				
23	150	250	0.75				
24	150	250	1				
25	150	250	1.25				

Table 34: Run protocol of Orange Pure II (200 ppm) - Activated Carbon

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	200	50	0.25				
2	200	50	0.5				
3	200	50	0.75				
4	200	50	1				
5	200	50	1.25				
6	200	100	0.25				
7	200	100	0.5				
8	200	100	0.75				
9	200	100	1				
10	200	100	1.25				
11	200	150	0.25				
12	200	150	0.5				
13	200	150	0.75				
14	200	150	1				
15	200	150	1.25				
16	200	200	0.25				
17	200	200	0.5				
18	200	200	0.75				
19	200	200	1				
20	200	200	1.25				
21	200	250	0.25				
22	200	250	0.5				
23	200	250	0.75				
24	200	250	1				
25	200	250	1.25				

Table 35: Run protocol of Orange Pure II (200 ppm) - Peanut Hull

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Size (mm)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	200	50	3.327-2.380				
2	200	50	2.380-2.362				
3	200	50	2.362-0.600				
4	200	50	0.600-0.425				
5	200	50	<0.425				
6	200	100	3.327-2.380				
7	200	100	2.380-2.362				
8	200	100	2.362-0.600				
9	200	100	0.600-0.425				
10	200	100	<0.425				
11	200	150	3.327-2.380				
12	200	150	2.380-2.362				
13	200	150	2.362-0.600				
14	200	150	0.600-0.425				
15	200	150	<0.425				
16	200	200	3.327-2.380				
17	200	200	2.380-2.362				
18	200	200	2.362-0.600				
19	200	200	0.600-0.425				
20	200	200	<0.425				
21	200	250	3.327-2.380				
22	200	250	2.380-2.362				
23	200	250	2.362-0.600				
24	200	250	0.600-0.425				
25	200	250	<0.425				

Table 36: Run protocol of Orange Pure II (200 ppm) - Banana Peel

S.No.	Dye Concentration (ppm)	Milk Concentration (ppm)	Adsorbent Concentration (g)	Absorbance		Transmittance	
				B.T	A.T	B.T	A.T
1	200	50	0.25				
2	200	50	0.5				
3	200	50	0.75				
4	200	50	1				
5	200	50	1.25				
6	200	100	0.25				
7	200	100	0.5				
8	200	100	0.75				
9	200	100	1				
10	200	100	1.25				
11	200	150	0.25				
12	200	150	0.5				
13	200	150	0.75				
14	200	150	1				
15	200	150	1.25				
16	200	200	0.25				
17	200	200	0.5				
18	200	200	0.75				
19	200	200	1				
20	200	200	1.25				
21	200	250	0.25				
22	200	250	0.5				
23	200	250	0.75				
24	200	250	1				
25	200	250	1.25				

3.5. Procedure

The preparation of dye wastewater is started by preparing a mother sample of 1000 ppm of dye wastewater. 1gm of dye is weighed by using the weigh balance and it is mixed in 1000 ml of water to prepare a mother sample of 1000 ppm of dye wastewater. In the same process 1gm of milk powder is weighed and it is mixed with 1000ml of water to make a solution 1000 ppm of milk wastewater. From the two mother samples of dye and milk wastewater desire quantity of combined dye and milk wastewater is prepared. The combined dye and milk wastewater thus obtained is measured for the absorbance and transmittance values before treating it with adsorbents. The NPOC values were also determined for the dye and milk wastewater using TOC analyzer. Once the absorbance, transmittance and NPOC values before treatment are determined the dye and milk combined wastewater of desired concentration is taken into sample bottles and then mixed with measured quantity of the adsorbents into it. Then the sample bottles are placed on mechanical shaker at an RPM of 100 for 1 minute and at an RPM of 30 for 30 minutes. The sample bottles are allowed to settle over-night. Once the sample bottles are allowed to settle then the wastewater is filtered using whatman 41 filter papers. Once the water is filtered then absorbance and transmittance values are again calculated. The same procedure is repeated for different dyes for their respective dye concentrations.

CHAPTER IV

RESULTS AND DISCUSSIONS

The results of all runs (900) are presented in the appendix as follows:

1. Appendix A are the tables of all runs
2. Appendix B are the figures of all runs

The observations and results were tabulated to explain the behavior and performance of three different adsorbents on different dye concentrations combined with different milk wastewater concentration.

Here after, the absorbance and transmittance values were taken before and after treatments may be referred as follows;

BT - Before treatment

AT - After Treatment

4.1. Rhodamine 6 G

Rhodamine 6 G got the highest transmittance value of 95.93 when treated with activated carbon at its lowest concentration of 20 ppm and milk wastewater concentration at 50 ppm. When Rhodamine 6 G is treated with peanut hull at a concentration of 20 ppm and milk wastewater concentration of 50 ppm and achieved a transmittance value of 76.03. At a concentration of 20 ppm of dye and 50 ppm of milk wastewater, the highest transmittance value of 84.07 is achieved when treated with banana peel powder. The following table explains the various transmittance values for different dye concentrations Rhodamine 6 G.

Table 37: Transmittance values for Rhodamine 6 G at different Concentrations

Dye Concentration	Activated Carbon	Peanut Hull	Banana Peel
Low **20 ppm**	95.93	76.03	84.07
Lower Medium **40 ppm**	95.02	74.68	82.27
Upper Medium **60 ppm**	93.76	71.89	79.72
High **80 ppm**	92.89	69.68	75.81

Figure below is used to represent as a representation of subsequent bar graphs to view the statistical relationship for the data that has been provided in the above table.

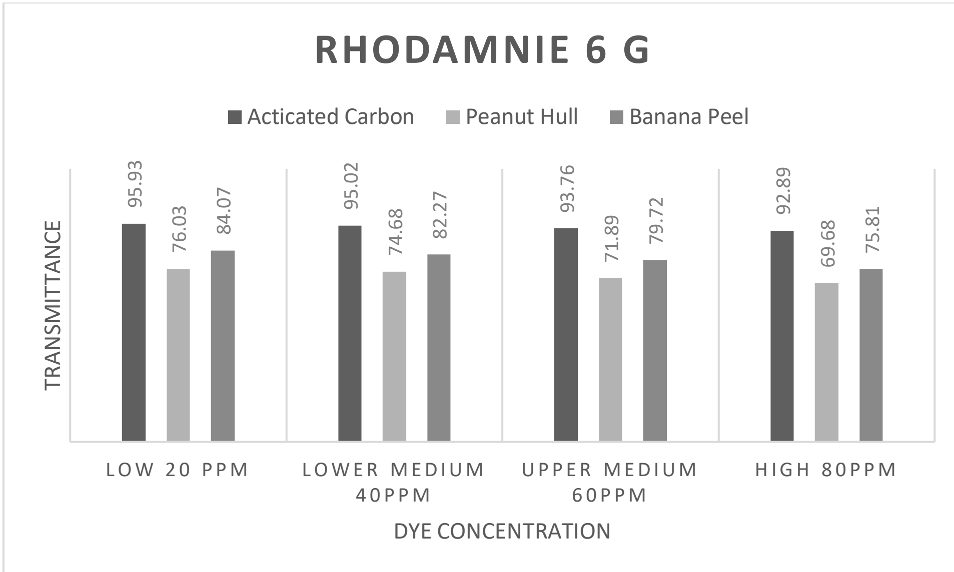

Figure 1: Plot for Transmittance values of Rhodamine 6 G at different Concentrations

For high concentration of Rhodamine 6 G dye the following table shows the NPOC values that are calculated for different adsorbents used.

Table 38: NPOC values for Rhodamine 6 G at high concentration

Milk Wastewater Concentration	Activated Carbon	Peanut Hull	Banana Peel
50 ppm Milk wastewater	3.36	7.36	5.21
	2.98	7.54	5.35
	2.89	6.69	4.96
	3.54	6.97	4.73
	3.76	7.53	5.22
100 ppm Milk Wastewater	6.54	10.58	7.54
	6.37	10.47	7.53
	5.87	9.89	6.97
	5.92	10.76	7.48
	6.34	9.89	7.35
150 ppm Milk Wastewater	9.36	13.87	11.32
	8.76	13.65	11.54
	9.54	13.57	10.96
	8.89	12.96	11.24
	9.54	12.89	11.57
200 ppm Milk Wastewater	14.42	17.66	16.34
	14.43	16.86	15.89
	13.89	16.89	15.89
	14.34	17.65	16.37
	13.89	17.59	16.37
250 ppm Milk Wastewater	18.63	23.26	21.36
	17.69	23.37	21.22
	18.63	22.89	20.89
	18.45	22.93	21.54
	18.54	23.31	20.97

Figure below is used to represent the graph plotted for the NPOC values that are obtained after the combined dye and milk wastewater treated with different adsorbents at maximum concentration of dye.

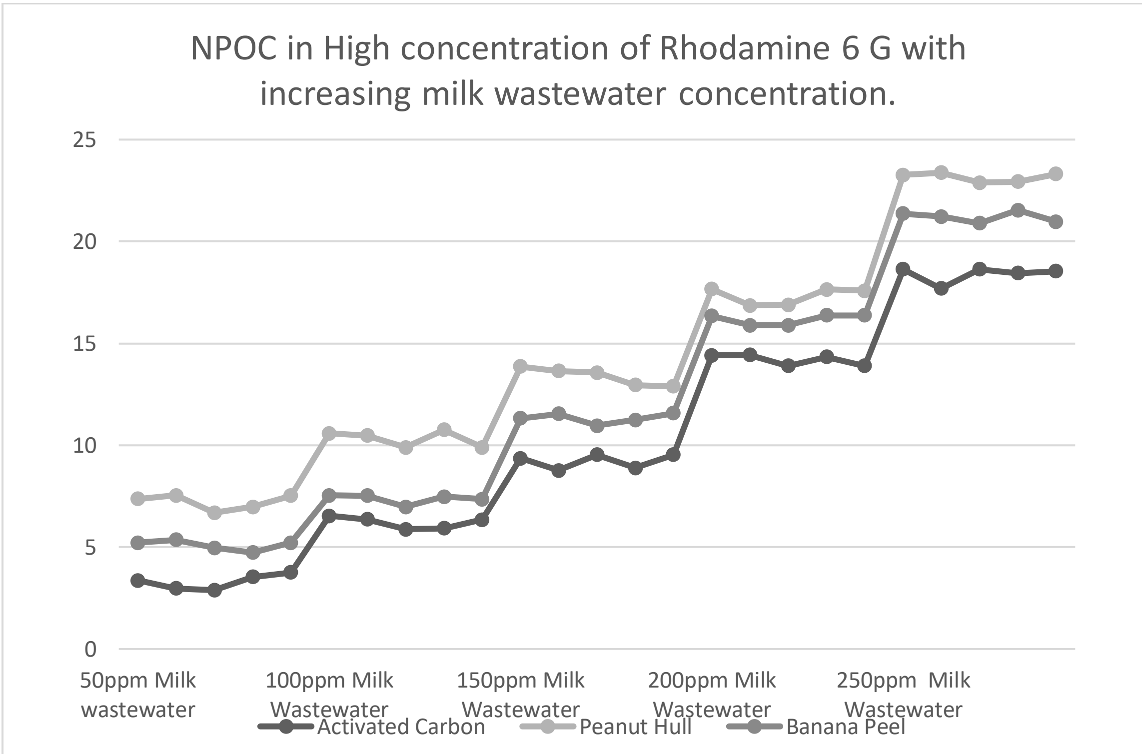

Figure 2: NPOC values for Rhodamine 6 G at high concentration of dye.

4.2. Acid Yellow

Acid Yellow got the highest transmittance value of 95.16 when treated with activated carbon at its lowest concentration of 25 ppm and milk wastewater concentration at 50 ppm. When Acid Yellow is treated with peanut hull at a concentration of 25 ppm and milk wastewater concentration of 50 ppm and achieved a transmittance value of 72.86. At a concentration of 25 ppm of dye and 50 ppm of milk wastewater, the highest transmittance value of 83.86 is achieved when treated with banana peel powder. The following table explains the various transmittance values for different dye concentrations of Acid Yellow.

Table 39: Transmittance values for Acid Yellow at different Concentrations

Dye Concentration	Activated Carbon	Peanut Hull	Banana Peel
Low **25 ppm**	95.16	72.86	83.86
Lower Medium **50 ppm**	93.67	71.68	81.86
Upper Medium **75 ppm**	92.89	68.71	80.75
High **100 ppm**	91.58	65.76	78.89

Figure below is used to represent as a representation of subsequent bar graphs to view the statistical relationship for the data that has been provided in the above table.

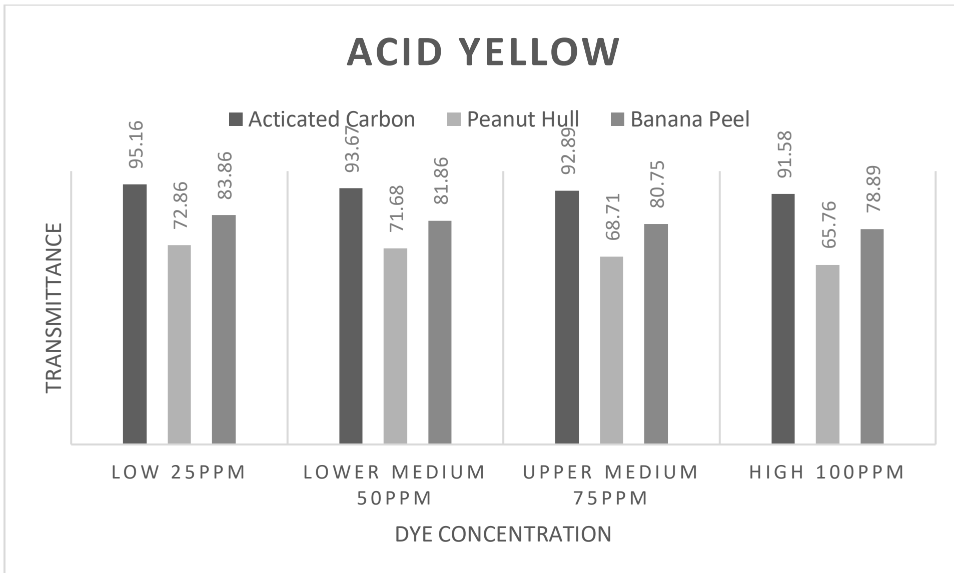

Figure 3: Plot for Transmittance values of Acid Yellow at different Concentrations

For high concentration of Acid Yellow dye, the following table shows the NPOC values that are calculated for different adsorbents used.

Table 40: NPOC values for high concentration of Acid Yellow

Milk Wastewater Concentration	Activated Carbon	Peanut Hull	Banana Peel
50 ppm Milk wastewater	5.45	12.54	15.36
	5.48	12.68	15.29
	4.96	12.12	14.96
	4.87	12.56	15.17
	5.54	12.19	15.27
100 ppm Milk Wastewater	9.65	16.09	17.55
	8.76	16.25	17.49
	9.54	15.86	17.06
	8.89	15.91	17.65
	9.54	16.08	17.54
150 ppm Milk Wastewater	12.37	19.41	20.35
	12.41	19.27	20.23
	11.98	18.89	20.16
	12.27	19.15	20.76
	12.36	19.41	20.37
200 ppm Milk Wastewater	14.76	23.15	21.32
	15.21	23.17	20.91
	15.19	22.87	20.89
	14.85	22.93	21.25
	15.22	23.15	21.37
250 ppm Milk Wastewater	20.26	25.42	23.45
	20.31	25.25	23.27
	19.89	25.48	23.57
	20.11	25.1	22.89
	20.36	25.42	23.23

Figure below is used to represent the graph plotted for the NPOC values that are obtained after the combined dye and milk wastewater treated with different adsorbents at maximum concentration of dye.

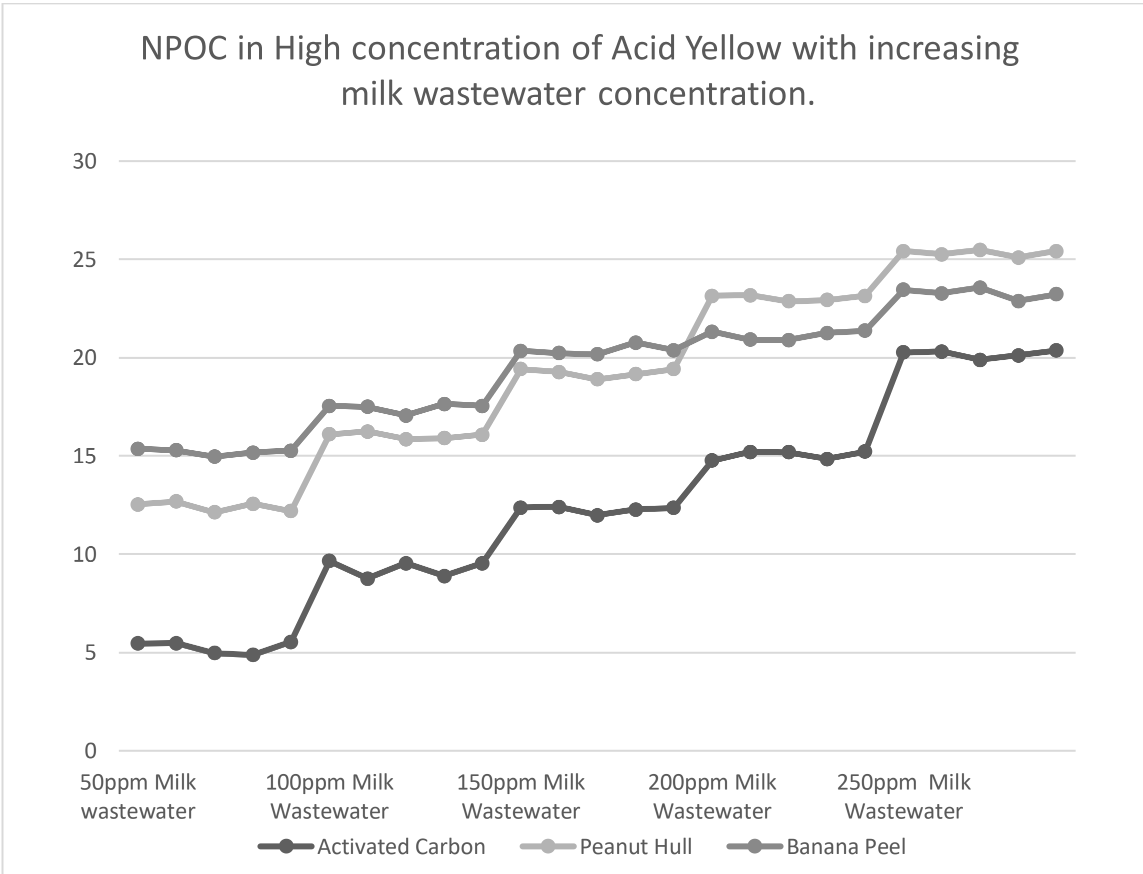

Figure 4: Plot for NPOC values of Acid yellow at high concentration

4.3 Orange Pure II

Orange Pure II got the highest transmittance value of 97.79 when treated with activated carbon at its lowest concentration of 50 ppm and milk wastewater concentration at 50 ppm. When Orange Pure II is treated with peanut hull at a concentration of 50 ppm and milk wastewater concentration of 50 ppm it achieved a transmittance value of 71.78. At a concentration of 50 ppm of dye and 50 ppm of milk wastewater, the highest transmittance value of 87.96 is achieved when treated with banana peel powder. The following table explains the various transmittance values for different dye concentrations of Orange Pure II.

Table 41: Transmittance values for Orange Pure II at different Concentrations

Dye Concentration	Activated Carbon	Peanut Hull	Banana Peel
Low **50 ppm**	97.79	71.78	87.96
Lower Medium **100 ppm**	95.61	70.71	85.76
Upper Medium **150 ppm**	95.89	68.96	83.84
High **200 ppm**	92.89	64.89	79.84

Figure below is used to represent as a representation of subsequent bar graphs to view the statistical relationship for the data that has been provided in the above table.

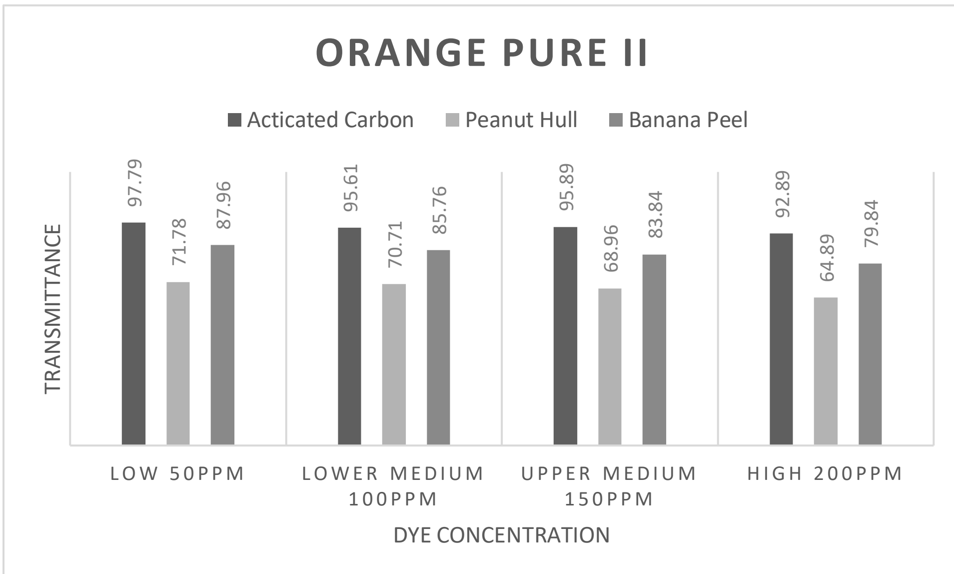

Figure 5: Plot for Transmittance values of orange pure II at different Concentrations

For high concentration of Orange Pure II dye, the following table shows the NPOC values that are calculated for different adsorbents used.

Table 42: NPOC values for high concentration of Orange Pure II after treatment

Milk Wastewater Concentration	Activated Carbon	Peanut Hull	Banana Peel
50 ppm Milk wastewater	7.25	15.35	11.02
	7.16	15.01	10.75
	6.92	14.65	11.38
	6.92	15.23	11.26
	7.11	15.71	11.57
100 ppm Milk Wastewater	9.85	17.89	15.77
	9.64	17.23	15.62
	8.87	17.54	14.89
	9.27	16.35	14.67
	9.75	17.78	15.27
150 ppm Milk Wastewater	12.36	19.45	18.51
	11.87	19.69	17.52
	11.66	18.96	17.69
	12.87	19.35	18.36
	12.54	19.57	18.75
200 ppm Milk Wastewater	15.47	22.36	23.21
	15.81	21.89	22.75
	14.66	22.06	23.68
	15.28	22.78	23.1
	15.89	22.52	23.57
250 ppm Milk Wastewater	17.36	29.26	27.36
	17.58	29.01	27.95
	18.63	28.67	26.54
	18.45	29.54	26.89
	18.54	29.32	27.98

Figure below is used to represent the graph plotted for the NPOC values that are obtained after the combined dye and milk wastewater treated with different adsorbents at maximum concentration of dye.

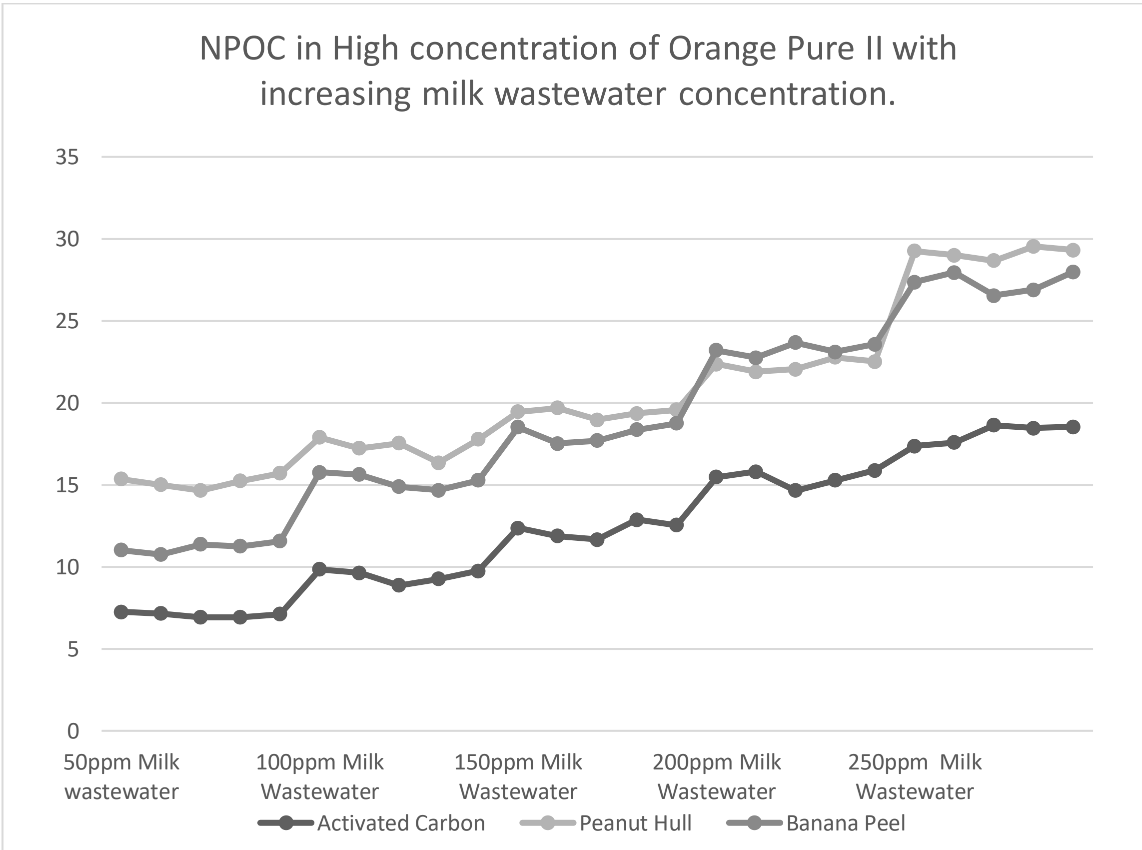

Figure 6: Plot for NPOC values of Orange Pure II at high concentration

4.4 Results of pH of Wastewater

The process of adsorption may be affected by the changes in pH concentrations. In general, depending upon the characteristic of the dye the pH concentrations may be changed. Depending upon the cationic or anionic dye adsorption pH varies. Here in this thesis the pH values obtained for Rhodamine 6 G, Acid Yellow and Orange Pure II are (9.1, 7.6, 8.3), (7.1, 8.5, 6.9) and (5.2, 5.9, 4.7) when treated with activated carbon, peanut hull and banana peel powder.

4.5 Results of Isotherms

The results of Isotherms are represented in the figures in Appendix B from B37 to B54.

Langmuir isotherm model fits best for Rhodamine 6 G at the optimum dosage of low-cost adsorbents with linear equation: y = 433.43x + 0.0626 and Coefficient of determination R^2 = 0.9323.

Langmuir isotherm model fits best for Acid yellow at the optimum dosage of low-cost adsorbents with linear equation: y = 276.41x + 0.0032 and Coefficient of determination R^2 = 0.9995.

Langmuir isotherm model fits best for Orange Pure II at the optimum dosage of low-cost adsorbents with linear equation: y = 474.64x - 0.0204 and Coefficient of determination R^2 = 0.9977.

4.6 Effect of Parameters on Color Removal of Wastewater

There are different factors which are considered for this research work. Absorbance and transmittance are the two main factors that represent the color removal from the combined dye and milk wastewater. Higher transmittance and lower absorbance indicates the best removal of color. pH is considered as neutral for this research work. As the experiments are carried out in the lab, temperature is considered as room temperature. When NPOC is considered the maximum treatment values are achieved when minimum NPOC values are obtained.

CHAPTER V

CONCLUSIONS

5.1 Conclusions

Based on the research work I have conducted using three different kind of adsorbents for treating the dye wastewater mixed with dairy wastewater, the following conclusions are made.

1. Rhodamine 6 G got the highest transmittance of 96% when treated with powdered activated carbon (PAC) at its lowest dye and milk waste concentrations respectively.

2. When treated with peanut hull and banana peel powder, the highest transmittance values of 76% and 84% are achieved for the lowest concentrations of dye and milk wastewater respectively.

3. Acid Yellow got the highest transmittance of 94% when treated with powdered activated carbon (PAC) at its lowest dye and milk waste concentrations respectively.

4. When treated with peanut hull and banana peel powder, the highest transmittance values of 72% and 81% are achieved for the lowest concentrations of acid yellow dye and milk wastewater respectively.

5. Orange Pure II got the highest transmittance of 97% when treated with powdered activated carbon (PAC) at its lowest dye and milk waste concentrations respectively.

6. When treated with peanut hull and banana peel powder, the highest transmittance values of 70% and 89% are achieved for the lowest concentrations of orange pure II dye and milk wastewater respectively.

7. Banana peel powder gave better results when compared to that of peanut hull in removal of color from dye and milk wastewater considering the results obtained by using powdered activated carbon for adsorption as reference.

5.2 Engineering Applications

The combined two stage treatment consists of adsorption and microfiltration which can be used effectively to remove color from different dye wastewaters. However, cost effective analysis can be performed regarding microfiltration processes.

Limitation of microfiltration regarding wastewater flow must be considered.

5.3 Recommendations for Future Research

For the future research, different treatment techniques with different dyes using different adsorbents can be carried out using this research as base. The results thus obtained can be analyzed in obtaining the best low-cost method of treatment. The disposal techniques for the adsorbents must be analyzed in order to provide a safer disposal of the adsorbents that are obtained after treatment.

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APPENDIX A: Tables

A1. Rhodamine 6 G (20 ppm) - Activated Carbon

Milk Concentration (ppm)	**50 PPM**		**100 PPM**		**150 ppm**		**200 ppm**		**250 ppm**	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	24.2	94.6	19.4	90.3	16.8	85.6	13.4	82.8	9.86	79.7
0.50g	24.7	94.9	19.9	90.8	17.0	85.9	13.7	83.1	10.3	80.1
0.75g	25.3	95.3	20.3	91.3	17.6	86.4	14.3	83.4	10.5	80.5
1.00g	25.9	95.6	20.7	91.7	17.9	86.8	14.7	83.7	10.9	80.8
1.25g	26.0	97.9	21.1	93.9	18.2	89.2	15.4	85.9	11.0	83.0

A2. Rhodamine 6 G (20 ppm) - Peanut Hull

Milk Concentration (ppm)	**50 ppm**		**100 ppm**		**150 ppm**		**200 ppm**		**250 ppm**	
Adsorbent size (mm)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
3.327-2.380	24.2	74.3	19.4	70.5	16.8	63.7	13.4	61.8	9.86	52.7
2.380-2.362	24.7	74.9	19.9	70.8	17.0	64.1	13.7	62.1	10.3	53.0
2.362-0.600	25.3	75.3	20.3	71.0	17.6	64.7	14.3	62.6	10.5	53.3
0.600-0.425	25.9	75.8	20.7	71.4	17.9	65.0	14.7	62.9	10.9	53.6
<0.425	26.0	78.0	21.1	73.8	18.2	67.3	15.4	65.0	11.0	55.9

A3. Rhodamine 6 G (20 ppm) - Banana Peel

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
0.25g	24.2	82.8	19.4	77.7	16.8	72.3	13.48	67.5	9.86	62.5
0.50g	24.7	83.1	19.9	78.1	17.0	72.7	13.75	67.9	10.31	62.8
0.75g	25.3	83.4	20.3	78.5	17.6	73.0	14.32	68.2	10.58	63.1
1.00g	25.9	83.8	20.7	78.9	17.9	73.3	14.72	68.6	10.96	63.5
1.25g	26.0	84.9	21.1	80.0	18.2	75.6	15.43	70.2	11.06	64.9

A4. Rhodamine 6 G (40 ppm) - Activated Carbon

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
0.25g	23.4	93.7	17.52	88.6	11.48	82.7	6.85	80.8	4.86	78.7
0.50g	23.9	93.9	17.93	88.8	11.86	82.9	7.1	81.0	5.07	79
0.75g	24.2	94.2	18.26	89.1	12.12	83.2	7.32	81.3	5.26	79.2
1.00g	24.7	94.6	18.69	89.5	12.46	83.5	7.65	81.6	5.55	79.5
1.25g	25.0	95.0	18.98	90.2	12.87	84.2	7.93	82.6	5.95	80.6

A5. Rhodamine 6 G (40 ppm) - Peanut Hull

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent size (mm)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
3.327-2.380	23.4	72.8	17.5	69.7	11.4	62.5	6.8	58.6	4.8	56.6
2.380-2.362	23.9	73.0	17.9	69.9	11.8	62.8	7.1	58.8	5.0	56.8
2.362-0.600	24.2	73.3	18.2	70.2	12.1	63.1	7.3	60.2	5.2	57.2
0.600-0.425	24.7	73.6	18.6	70.7	12.4	63.5	7.6	60.4	5.5	57.6
<0.425	25.0	74.6	18.9	71.8	12.8	64.3	7.9	61.2	5.9	58.8

A6. Rhodamine 6 G (40 ppm) - Banana Peel

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	23.4	80.7	17.5	76.6	11.4	70.5	6.85	65.46	4.86	60.5
0.50g	23.9	80.9	17.9	76.9	11.8	70.8	7.1	65.72	5.07	60.9
0.75g	24.2	81.3	18.2	77.2	12.1	71.2	7.32	66.08	5.26	61.3
1.00g	24.7	81.6	18.6	77.5	12.4	71.6	7.65	66.45	5.55	61.6
1.25g	25.0	82.2	18.9	78.4	12.8	72.3	7.93	67.36	5.95	62.5

A7. Rhodamine 6 G (60 ppm) - Activated Carbon

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
0.25g	19.85	91.75	14.8	86.87	9.81	81.5	4.9	79.6	2.9	77.5
0.50g	20.06	92.05	15	87.13	10.1	81.9	5.4	79.9	3.15	77.9
0.75g	20.35	92.48	15.3	87.49	10.4	82.2	5.6	80.2	3.57	78.3
1.00g	20.69	92.87	15.6	87.77	10.6	82.5	5.9	80.6	3.85	78.6
1.25g	20.94	93.76	15.9	88.72	11	83.7	6.1	81.5	4.1	79.9

A8. Rhodamine 6 G (60 ppm) - Peanut Hull

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent size (mm)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
3.327-2.380	19.85	69.5	14.75	68.3	9.81	60.4	4.92	56.5	2.9	54.36
2.380-2.362	20.06	69.8	14.96	68.7	10.08	60.8	5.35	56.9	3.15	54.68
2.362-0.600	20.35	70.2	15.29	69.0	10.37	61.1	5.58	57.1	3.57	54.96
0.600-0.425	20.69	70.5	15.58	69.5	10.6	61.5	5.87	57.5	3.85	55.35
<0.425	20.94	71.8	15.87	70.6	10.95	62.8	6.05	58.7	4.1	56.67

A9. Rhodamine 6 G (60 ppm) - Banana Peel

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	19.8	77.3	14.7	74.5	9.8	69.4	4.92	64.4	2.9	59.5
0.50g	20.0	77.6	14.9	74.8	10.0	69.8	5.35	64.8	3.15	59.9
0.75g	20.3	77.9	15.2	75.1	10.3	70.2	5.58	65.0	3.57	60.2
1.00g	20.6	78.6	15.5	75.5	10.6	70.6	5.87	65.4	3.85	60.6
1.25g	20.9	79.7	15.8	76.8	10.9	71.5	6.05	66.5	4.1	61.8

A10. Rhodamine 6 G (80 ppm) - Activated Carbon

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	16.6	90.3	12.5	85.4	8.7	80.5	3.67	78.4	1.86	74.5
0.50g	16.9	90.6	12.8	85.8	8.9	80.9	3.89	78.7	2.15	74.8
0.75g	17.3	91.1	13.5	86.3	9.3	81.2	4.47	79.0	2.36	75.1
1.00g	17.6	91.5	13.8	86.6	9.6	81.6	4.78	79.5	2.57	75.6
1.25g	17.9	92.8	14.0	87.8	9.9	82.7	4.93	80.7	2.81	76.4

A11. Rhodamine 6 G (80 ppm) - Peanut Hull

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent size (mm)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
3.327-2.380	16.6	67.8	12.5	65.5	8.75	59.64	3.67	57.68	1.86	52.6
2.380-2.362	16.9	68.0	12.8	65.8	8.91	59.96	3.89	57.89	2.15	52.9
2.362-0.600	17.3	68.3	13.5	66.2	9.35	60.12	4.47	58.26	2.36	53.1
0.600-0.425	17.6	68.5	13.8	66.6	9.67	60.54	4.78	58.58	2.57	53.5
<0.425	17.9	69.6	14.0	67.7	9.96	61.58	4.93	59.63	2.81	54.6

A12. Rhodamine 6 G (80 ppm) - Banana Peel

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
0.25g	16.6	73.6	12.5	70.6	8.7	66.5	3.6	61.4	1.8	58.4
0.50g	16.9	73.9	12.8	70.8	8.9	66.8	3.8	61.7	2.1	58.7
0.75g	17.3	74.3	13.5	71.2	9.3	67.3	4.4	62.0	2.3	59.1
1.00g	17.6	74.6	13.8	71.5	9.6	67.7	4.7	62.5	2.5	59.5
1.25g	17.9	75.8	14.0	72.7	9.9	68.9	4.9	63.6	2.8	60.7

A13. Acid Yellow (25 ppm) - Activated Carbon

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
0.25g	38.9	93.7	35.8	90.8	31.9	88.8	26.8	85.6	23.8	80.8
0.50g	39.3	94.1	36.1	91.0	32.1	89.1	26.1	85.9	24.0	81.0
0.75g	39.7	94.5	36.5	91.3	32.4	89.5	26.4	86.2	24.3	81.3
1.00g	40.0	94.8	36.9	91.6	32.7	89.9	26.8	86.5	24.6	81.6
1.25g	40.4	97.1	37.2	93.9	33.0	92.0	27.0	88.8	24.9	83.8

A14. Acid Yellow (25 ppm) - Peanut Hull

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent size (mm)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
3.327-2.380	38.9	71.6	35.8	66.8	31.9	62.7	26.8	58.9	23.8	54.8
2.380-2.362	39.3	71.9	36.1	67.0	32.1	63.0	26.1	59.2	24.0	55.0
2.362-0.600	39.7	72.2	36.5	67.3	32.4	63.3	26.4	59.5	24.3	55.3
0.600-0.425	40.0	72.5	36.9	67.6	32.7	63.6	26.8	59.8	24.6	55.6
<0.425	40.4	74.8	37.2	69.9	33.0	65.9	27.0	62.0	24.9	57.8

A15. Acid Yellow (25 ppm) - Banana Peel

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
0.25g	38.9	80.7	35.8	77.9	31.9	72.7	26.8	70.8	23.8	61.8
0.50g	39.3	80.9	36.1	78.2	32.1	72.9	26.1	71.0	24.0	62.0
0.75g	39.7	81.2	36.5	78.6	32.4	73.2	26.4	71.3	24.3	62.2
1.00g	40.0	81.5	36.9	78.8	32.7	73.5	26.8	71.6	24.6	62.5
1.25g	40.4	83.8	37.2	81.0	33.0	75.8	27.0	73.8	24.9	64.7

A16. Acid Yellow (50 ppm) - Activated Carbon

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
0.25g	37.9	91.3	32.8	86.5	29.8	83.4	24.9	81.4	19.9	79.4
0.50g	38.2	91.7	33.0	86.9	30.1	83.8	25.1	81.8	20.2	79.8
0.75g	38.6	92.0	33.5	87.2	30.5	84.0	25.5	82.3	20.5	80.1
1.00g	38.9	92.5	33.7	87.6	30.8	84.5	25.8	82.7	20.8	80.5
1.25g	40.3	93.6	34.1	88.7	31.2	85.8	26.1	83.6	21.2	81.8

A17. Acid Yellow (50 ppm) - Peanut Hull

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent size (mm)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
3.327-2.380	37.9	69.4	32.8	65.4	29.8	62.5	24.9	60.6	19.9	58.5
2.380-2.362	38.2	69.8	33.0	65.8	30.1	62.9	25.1	60.9	20.2	58.8
2.362-0.600	38.6	70.1	33.5	66.2	30.5	63.2	25.5	61.3	20.7	59.3
0.600-0.425	38.9	70.5	33.7	66.6	30.8	63.6	25.8	61.7	20.8	59.6
<0.425	40.3	71.6	34.1	67.7	31.2	64.8	26.1	62.6	21.2	60.7

A18. Acid Yellow (50 ppm) - Banana Peel

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	37.9	79.5	32.8	76.5	29.8	73.4	24.9	69.6	19.9	66.5
0.50g	38.2	79.9	33.0	76.8	30.1	73.7	25.1	69.9	20.2	66.8
0.75g	38.6	80.2	33.5	77.1	30.5	74.1	25.5	70.3	20.5	67.2
1.00g	38.9	80.5	33.7	77.6	30.8	74.5	25.8	70.6	20.8	67.7
1.25g	40.35	81.8	34.1	78.8	31.2	75.6	26.1	71.5	21.2	68.8

A19. Acid Yellow (75 ppm) - Activated Carbon

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
0.25g	34.8	90.3	30.9	85.4	28.7	82.3	22.9	80.5	17.8	78.3
0.50g	35.1	90.8	31.3	85.7	29.0	82.9	22.2	80.9	18.1	78.7
0.75g	35.5	91.3	31.6	86.1	29.4	83.3	22.5	81.2	18.5	79.0
1.00g	35.9	91.5	31.9	86.6	29.8	83.8	22.8	81.5	18.8	79.5
1.25g	36.2	92.8	32.2	87.5	30.5	84.9	23.0	82.7	19.2	80.7

A20. Acid Yellow (75 ppm) - Peanut Hull

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent size (mm)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
3.327-2.380	34.8	66.5	30.9	62.3	28.7	60.4	22.9	56.4	17.8	53.5
2.380-2.362	35.1	66.8	31.3	62.7	29.0	60.9	22.2	56.8	18.1	53.9
2.362-0.600	35.5	67.2	31.6	63.0	29.4	61.3	22.5	57.3	18.5	54.4
0.600-0.425	35.9	67.6	31.9	63.5	29.8	61.6	22.8	57.7	18.8	54.8
<0.425	36.2	68.7	32.2	64.8	30.1	62.6	23.0	58.6	19.2	55.7

A21. Acid Yellow (75 ppm) - Banana Peel

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	34.8	78.5	30.9	75.3	28.7	71.5	22.9	68.4	17.8	64.5
0.50g	35.1	78.9	31.3	75.7	29.0	71.8	22.2	68.8	18.1	64.9
0.75g	35.5	79.3	31.6	76.2	29.4	72.3	22.5	69.1	18.5	65.2
1.00g	35.9	79.6	31.9	76.6	29.8	72.5	22.8	69.6	18.8	65.7
1.25g	36.2	80.7	32.2	77.5	30.1	73.8	23.0	70.5	19.2	66.8

A22. Acid Yellow (100 ppm) - Activated Carbon

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	31.8	89.6	29.8	84.56	24.7	81.4	20.89	79.2	16.8	77.58
0.50g	32.1	89.9	30.1	84.89	23.0	81.8	21.24	79.6	17.0	77.89
0.75g	32.5	90.2	30.5	85.36	23.4	82.3	21.57	80.0	17.4	78.34
1.00g	32.8	90.6	30.8	85.78	23.7	82.7	21.96	80.5	17.7	78.65
1.25g	33.2	91.5	31.1	86.89	24.1	83.8	22.34	81.7	18.1	79.83

A23. Acid Yellow (100 ppm) - Peanut Hull

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent size (mm)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
3.327-2.380	31.8	63.5	29.8	60.3	24.7	56.5	20.8	53.5	16.8	50.6
2.380-2.362	32.1	63.8	30.1	60.7	23.0	56.9	21.2	53.8	17.0	50.9
2.362-0.600	32.5	64.1	30.5	61.2	23.4	57.3	21.5	54.2	17.4	51.3
0.600-0.425	32.8	64.5	30.8	61.7	23.7	57.8	21.9	54.6	17.7	51.8
<0.425	33.2	65.7	31.1	62.8	24.1	58.6	22.3	55.7	18.1	52.9

A24. Acid Yellow (100 ppm) - Banana Peel

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
0.25g	31.8	76.5	29.8	72.4	24.7	70.6	20.8	68.5	16.8	62.5
0.50g	32.1	76.8	30.1	72.8	23.0	71.0	21.2	68.8	17.0	62.9
0.75g	32.5	77.3	30.5	73.4	23.4	71.4	21.5	69.2	17.4	63.4
1.00g	32.8	77.7	30.8	73.8	23.7	71.8	21.9	69.7	17.7	63.8
1.25g	33.2	78.8	31.1	74.7	24.1	72.7	22.3	70.8	18.1	64.9

A25. Orange Pure II (50 ppm) - Activated Carbon

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
0.25g	47.8	95.8	44.7	92.7	40.8	90.7	35.8	88.8	31.9	84.8
0.50g	48.0	96.0	44.9	92.9	41.0	90.9	36.1	89.0	32.2	85.0
0.75g	48.3	96.2	45.2	93.1	41.3	91.2	36.4	89.3	32.5	85.2
1.00g	48.6	96.5	45.5	93.4	41.5	91.5	36.7	89.6	32.8	85.5
1.25g	48.8	97.7	45.8	95.7	41.8	93.8	36.9	91.8	33.0	87.7

A26. Orange Pure II (50 ppm) - Peanut Hull

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent size (mm)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
3.327-2.380	47.8	69.7	44.7	64.8	40.8	60.8	35.8	56.7	31.9	48.8
2.380-2.362	48.0	69.9	44.9	65.1	41.0	61.0	36.1	56.9	32.2	49.0
2.362-0.600	48.3	70.1	45.2	65.4	41.3	61.3	36.4	57.1	32.5	49.2
0.600-0.425	48.6	70.4	45.5	65.6	41.5	61.6	36.7	57.4	32.8	49.5
<0.425	48.8	71.7	45.8	67.9	41.8	63.8	36.9	59.7	33.0	51.8

A27. Orange Pure II (50 ppm) - Banana Peel

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	47.8	85.9	44.7	80.8	40.8	78.8	35.8	72.9	31.9	67.8
0.50g	48.0	86.2	44.9	81.0	41.0	79.0	36.1	73.1	32.2	68.0
0.75g	48.3	86.5	45.2	81.3	41.3	79.2	36.4	73.3	32.5	68.2
1.00g	48.6	86.7	45.5	81.5	41.5	79.4	36.7	73.6	32.8	68.5
1.25g	48.8	87.9	45.8	83.7	41.8	81.6	36.9	75.8	33.0	70.7

A28. Orange Pure II (100 ppm) - Activated Carbon

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	44.8	93.6	40.7	91.5	37.8	89.6	31.8	86.5	26.7	82.5
0.50g	45.0	93.9	41.0	91.9	38.1	90.0	32.1	86.9	27.0	83.0
0.75g	45.3	94.2	41.3	92.3	38.4	90.3	32.5	87.2	27.5	83.3
1.00g	45.7	94.5	41.8	92.7	38.8	90.8	32.9	87.6	27.8	83.8
1.25g	46.1	95.6	42.3	93.6	39.4	91.8	33.3	88.7	28.1	84.6

A29. Orange Pure II (100 ppm) - Peanut Hull

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent size (mm)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
3.327-2.380	44.8	68.5	40.7	63.3	37.8	60.4	31.8	58.4	26.7	54.5
2.380-2.362	45.0	68.9	41.0	63.8	38.1	60.7	32.1	58.8	27.8	54.9
2.362-0.600	45.3	69.3	41.3	64.1	38.4	61.2	32.5	59.2	27.5	55.3
0.600-0.425	45.7	69.8	41.8	64.5	38.8	61.7	32.9	59.6	27.8	55.8
<0.425	46.1	70.7	42.3	65.7	39.4	62.8	33.3	60.7	28.1	56.7

A30. Orange Pure II (100 ppm) - Banana Peel

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	44.8	83.5	40.7	79.5	37.8	76.4	31.8	71.4	26.7	66.5
0.50g	45.0	83.9	41.0	79.8	38.1	76.8	32.1	71.7	27.0	66.8
0.75g	45.3	84.2	41.3	80.3	38.4	77.3	32.5	72.2	27.5	67.3
1.00g	45.7	84.6	41.8	80.6	38.8	77.7	32.9	72.5	27.8	67.8
1.25g	46.1	85.7	42.3	81.7	39.4	79.8	33.3	73.6	28.1	68.7

A31. Orange Pure II (150 ppm) - Activated Carbon

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	42.7	93.6	38.9	90.4	34.8	88.6	28.8	85.4	24.8	81.5
0.50g	43.0	93.9	39.2	90.8	35.1	88.9	29.0	85.8	25.0	81.8
0.75g	43.3	94.2	39.5	91.3	35.4	89.4	29.4	86.2	25.4	82.1
1.00g	43.8	94.6	39.8	91.6	35.8	89.8	29.7	86.6	25.7	82.6
1.25g	44.0	95.8	40.1	92.7	36.2	90.7	30.0	87.8	26.1	83.7

A32. Orange Pure II (150 ppm) - Peanut Hull

Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent size (mm)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
3.327-2.380	42.7	65.5	38.9	61.4	34.8	58.4	28.8	54.5	24.8	51.4
2.380-2.362	43.0	65.9	39.2	61.7	35.1	58.8	29.0	54.9	25.0	51.8
2.362-0.600	43.3	66.2	39.5	62.3	35.4	59.3	29.4	55.3	25.4	52.4
0.600-0.425	43.8	66.7	39.8	62.7	35.8	59.8	29.7	55.7	25.7	52.8
<0.425	44.0	68.9	40.1	63.8	36.2	60.9	30.0	56.8	26.1	53.9

A33. Orange Pure II (150 ppm) - Banana Peel

Milk Concentration (ppm)	**50 ppm**		**100 ppm**		**150 ppm**		**200 ppm**		**250 ppm**	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	42.7	81.6	38.9	78.4	34.8	75.6	28.8	71.5	24.8	68.5
0.50g	43.0	81.9	39.2	78.8	35.1	75.9	29.0	71.8	25.0	68.8
0.75g	43.3	82.3	39.5	79.2	35.4	76.4	29.4	72.3	25.4	69.1
1.00g	43.8	82.6	39.8	79.6	35.8	76.7	29.7	72.6	25.7	69.5
1.25g	44.0	83.8	40.1	80.7	36.2	77.9	30.0	73.8	26.1	70.8

A34. Orange Pure II (200 ppm) - Activated Carbon

Milk Concentration (ppm)	**50 ppm**		**100 ppm**		**150 ppm**		**200 ppm**		**250 ppm**	
Adsorbent Concentration (g)	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**	**B.T**	**A.T**
0.25g	38.8	90.3	35.7	88.5	31.8	86.4	24.8	84.5	20.7	79.5
0.50g	39.0	90.7	36.0	88.9	32.1	86.8	25.1	84.9	21.1	79.8
0.75g	39.4	91.0	36.4	89.2	32.5	87.2	25.5	85.3	21.5	80.2
1.00g	39.8	91.5	36.8	89.6	32.9	87.6	25.8	85.7	21.8	80.6
1.25g	40.2	92.8	37.7	90.8	33.9	88.8	26.8	86.7	22.8	81.8

A35. Orange Pure II (200 ppm) - Peanut Hull

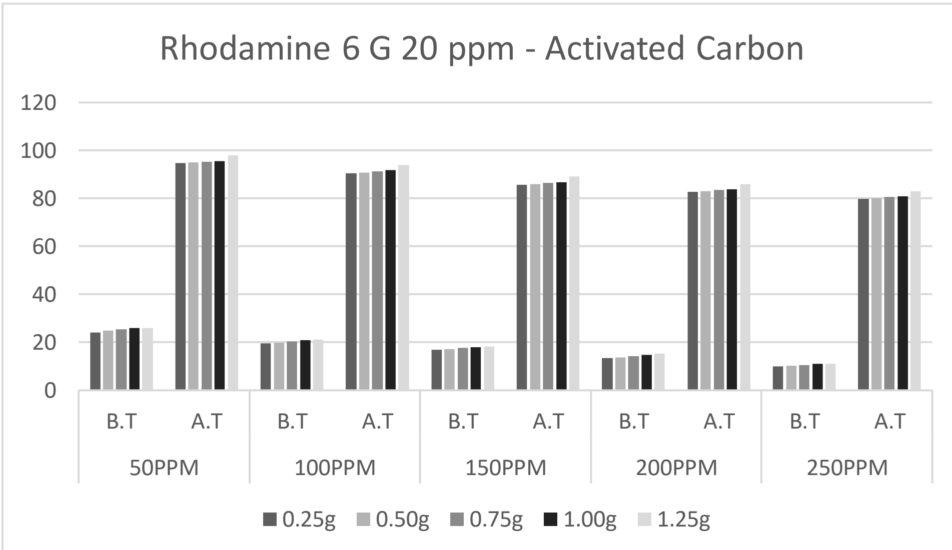
Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent size (mm)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
3.327-2.380	38.8	62.5	35.7	60.4	31.8	54.5	24.8	51.5	20.7	48.5
2.380-2.362	39.0	62.8	36.0	60.7	32.1	54.8	25.1	51.8	21.1	48.9
2.362-0.600	39.4	63.3	36.4	61.1	32.5	55.2	25.5	52.3	21.5	49.3
0.600-0.425	39.8	63.7	36.8	61.5	32.9	55.8	25.8	52.7	21.8	49.7
<0.425	40.2	64.8	37.7	62.7	33.9	56.9	26.8	53.8	22.8	50.8

A36. Orange Pure II (200 ppm) - Banana Peel

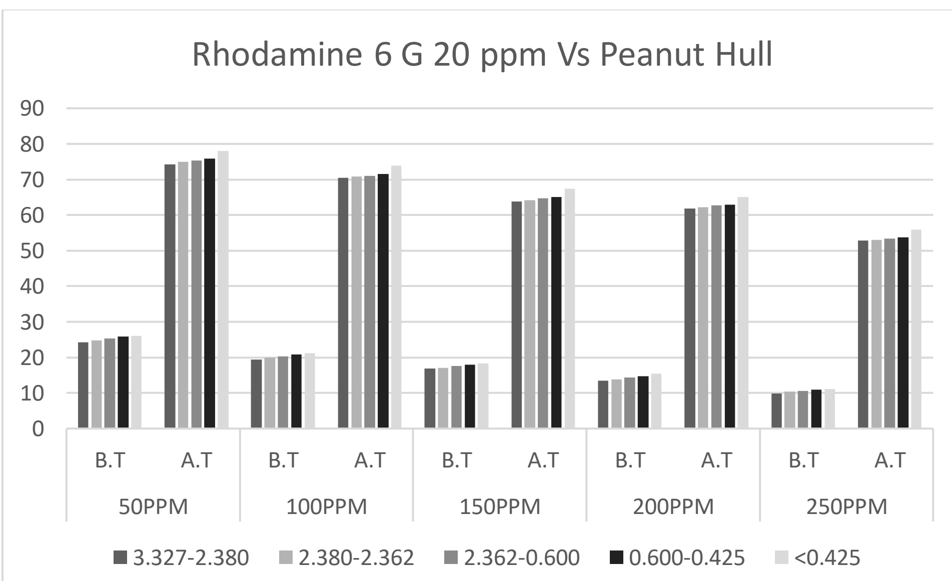
Milk Concentration (ppm)	50 ppm		100 ppm		150 ppm		200 ppm		250 ppm	
Adsorbent Concentration (g)	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T	B.T	A.T
0.25g	38.8	77.5	35.7	71.4	31.8	69.6	24.8	65.5	20.7	60.5
0.50g	39.0	77.8	36.0	71.8	32.1	69.9	25.1	65.8	21.1	60.8
0.75g	39.4	78.3	36.4	72.2	32.5	70.3	25.5	66.2	21.5	61.1
1.00g	39.8	78.6	36.8	72.8	32.9	70.8	25.8	66.7	21.8	61.5
1.25g	40.2	79.8	37.7	73.9	33.9	71.8	26.8	67.8	22.8	62.7

APPENDIX B: Figures

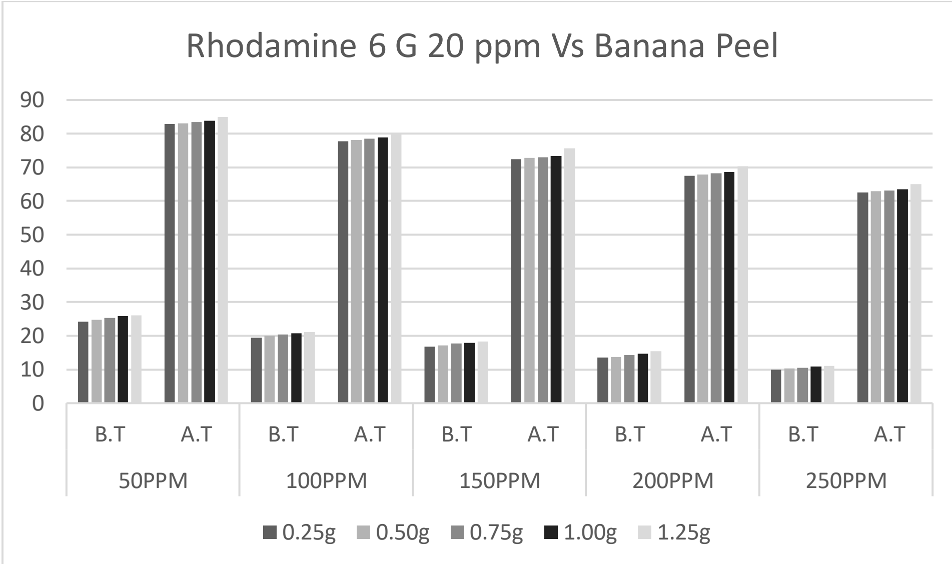
B1. Rhodamine 6 G (20 ppm) - Activated Carbon



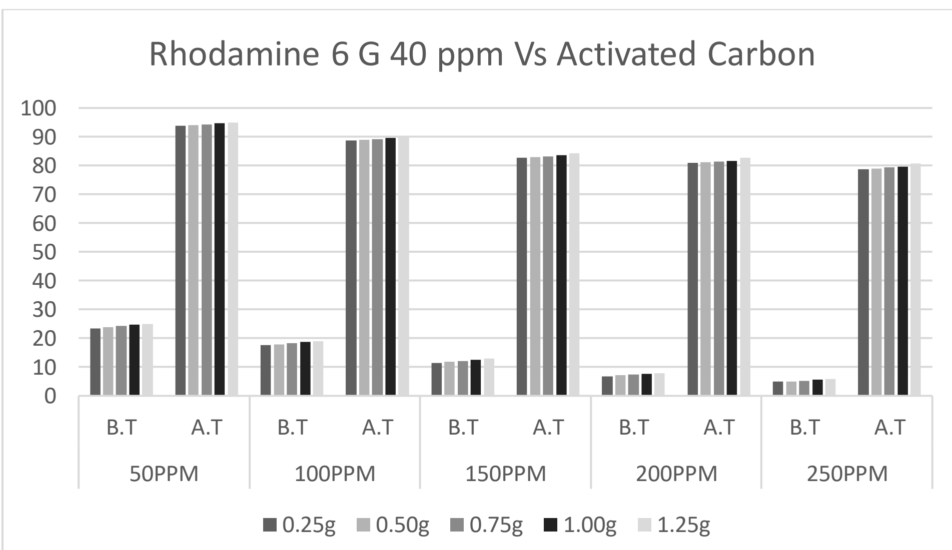
B2. Rhodamine 6 G (20 ppm) - Peanut Hull



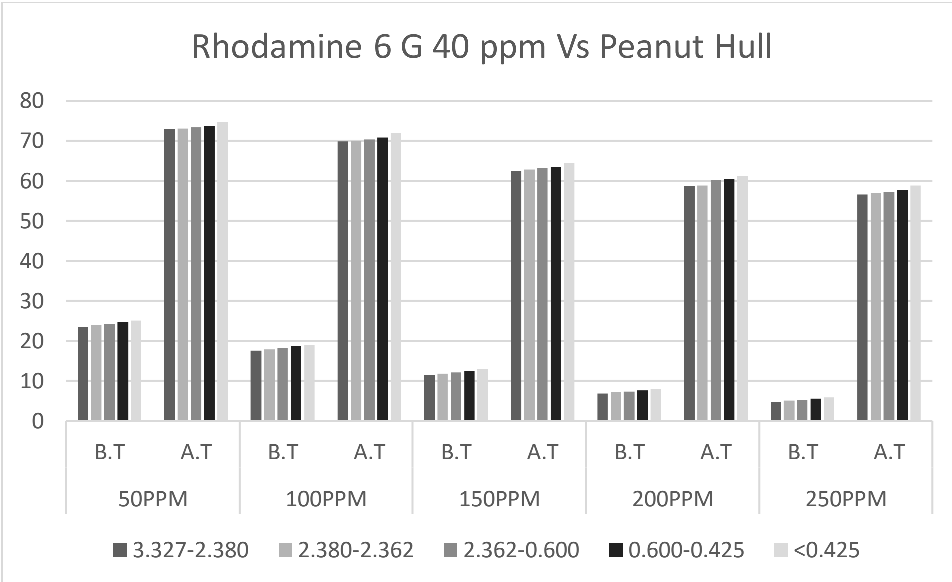
B3. Rhodamine 6 G (20 ppm) - Banana Peel



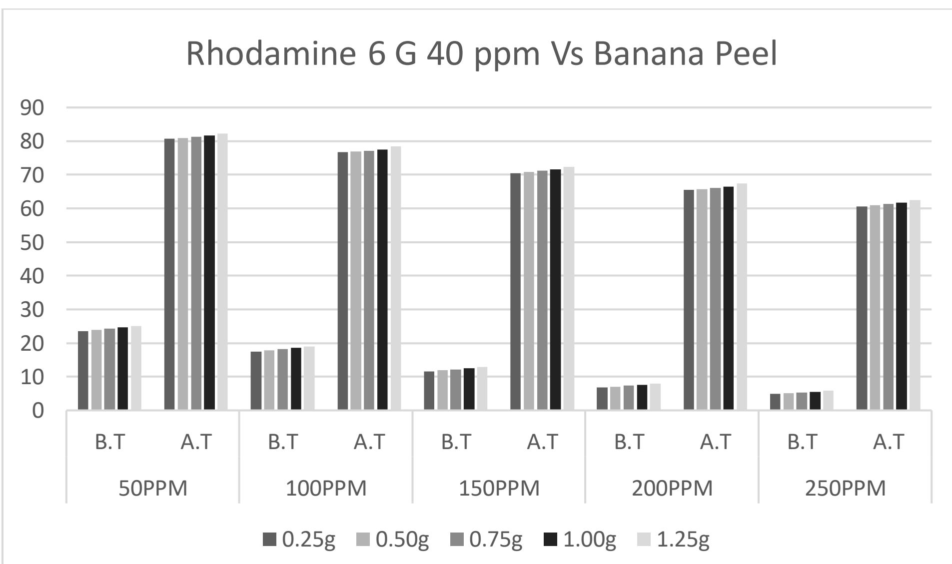
B4. Rhodamine 6 G (40 ppm) - Activated Carbon



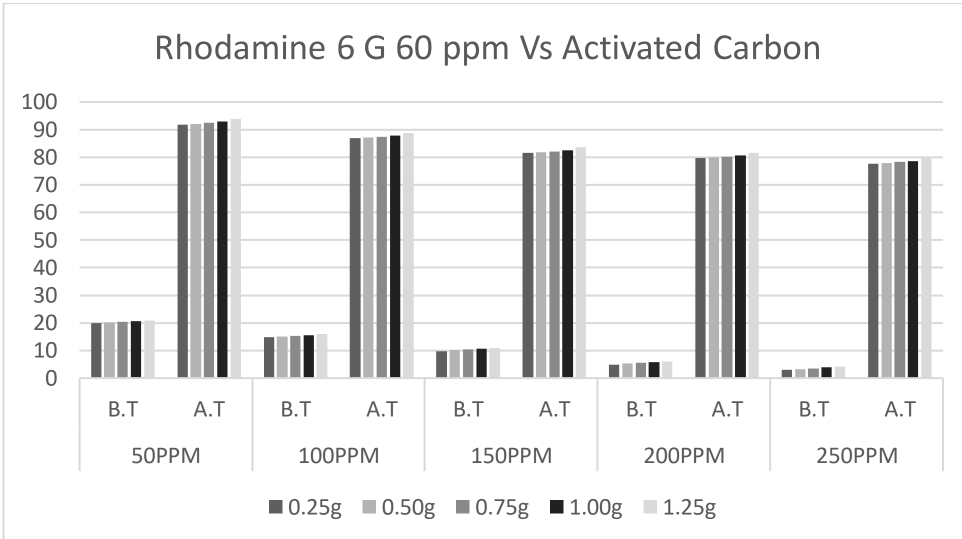
B5. Rhodamine 6 G (40 ppm) - Peanut Hull



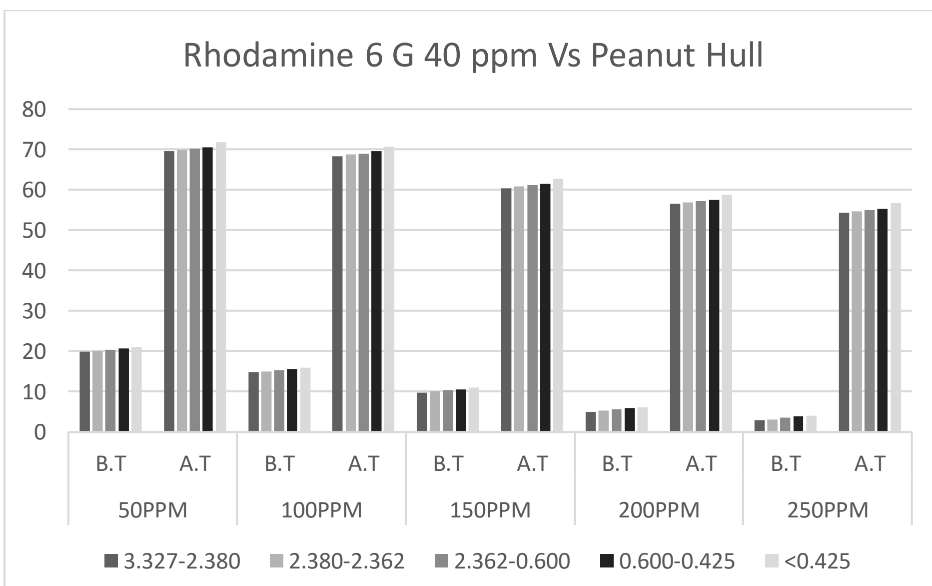
B6. Rhodamine 6 G (40 ppm) - Banana Peel



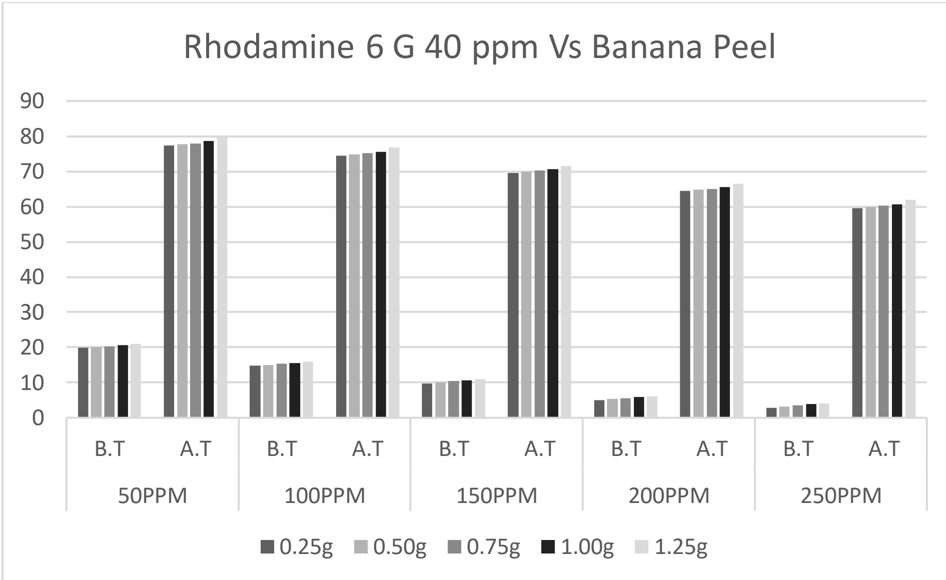
B7. Rhodamine 6 G (60 ppm) - Activated Carbon



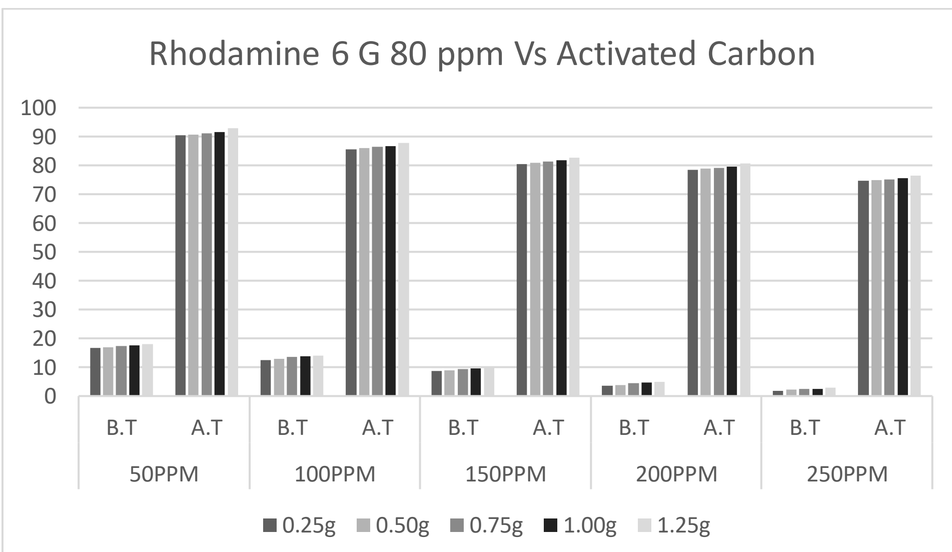
B8. Rhodamine 6 G (60 ppm) - Peanut Hull



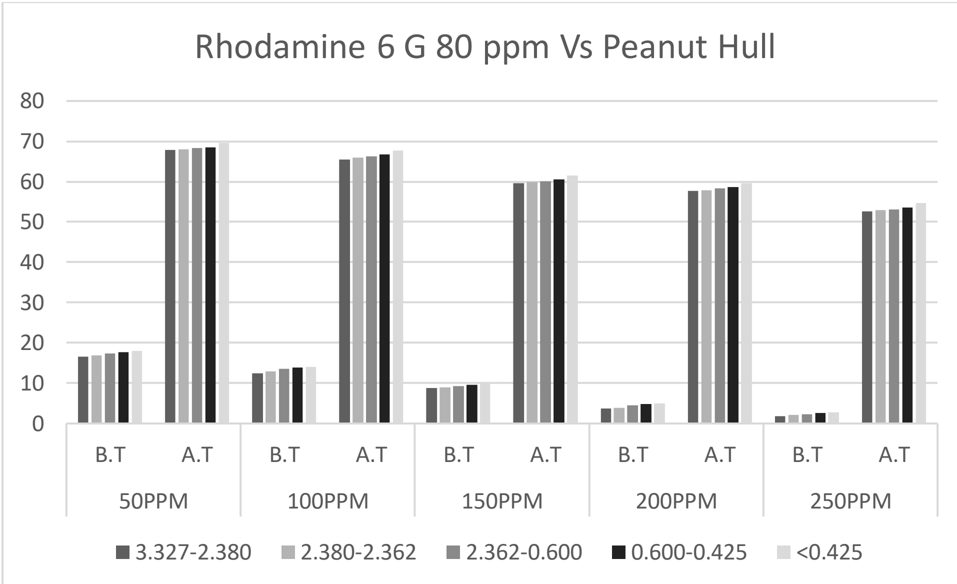
B9. Rhodamine 6 G (60 ppm) - Banana Peel



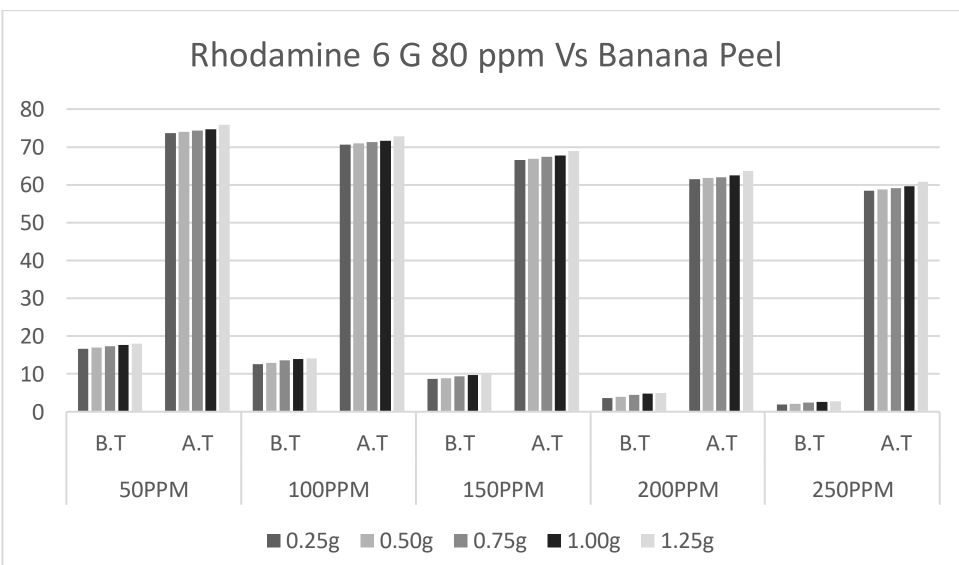
B10. Rhodamine 6 G (80 ppm) - Activated Carbon



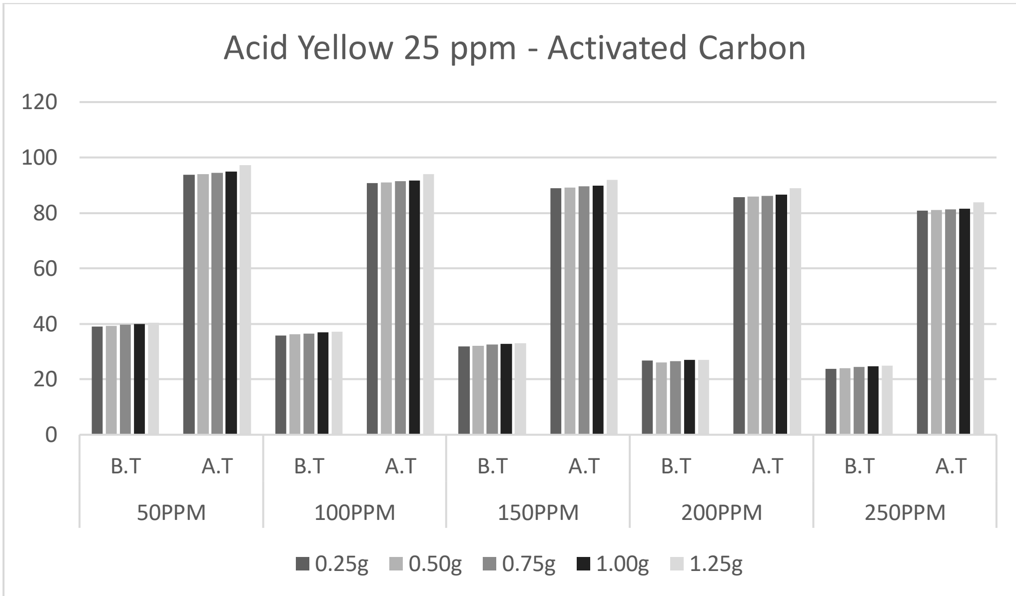
B11. Rhodamine 6 G (80 ppm) - Peanut Hull



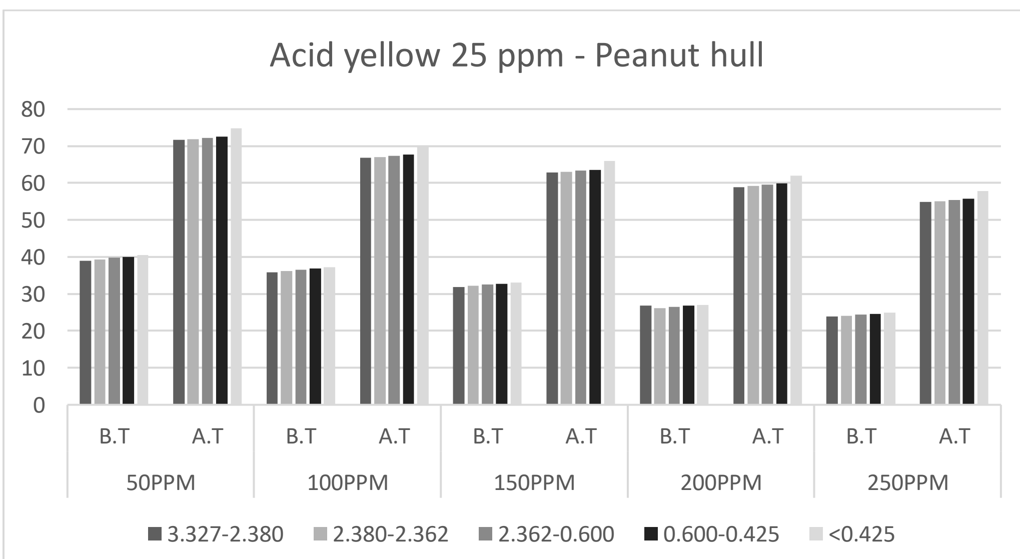
B12. Rhodamine 6 G (80 ppm) - Banana Peel



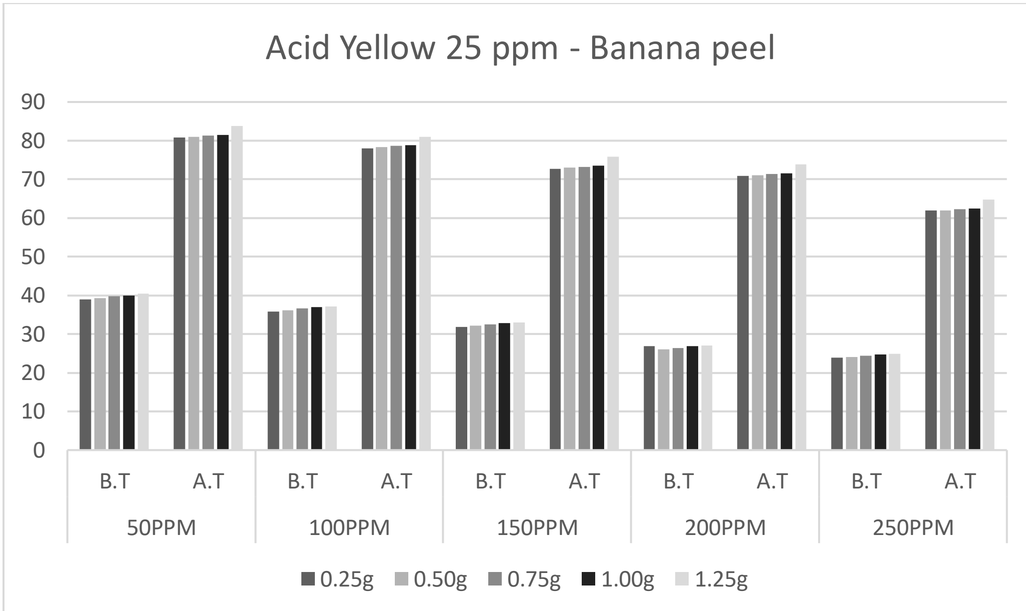
B13. Acid Yellow 11 (25 ppm) - Activated Carbon



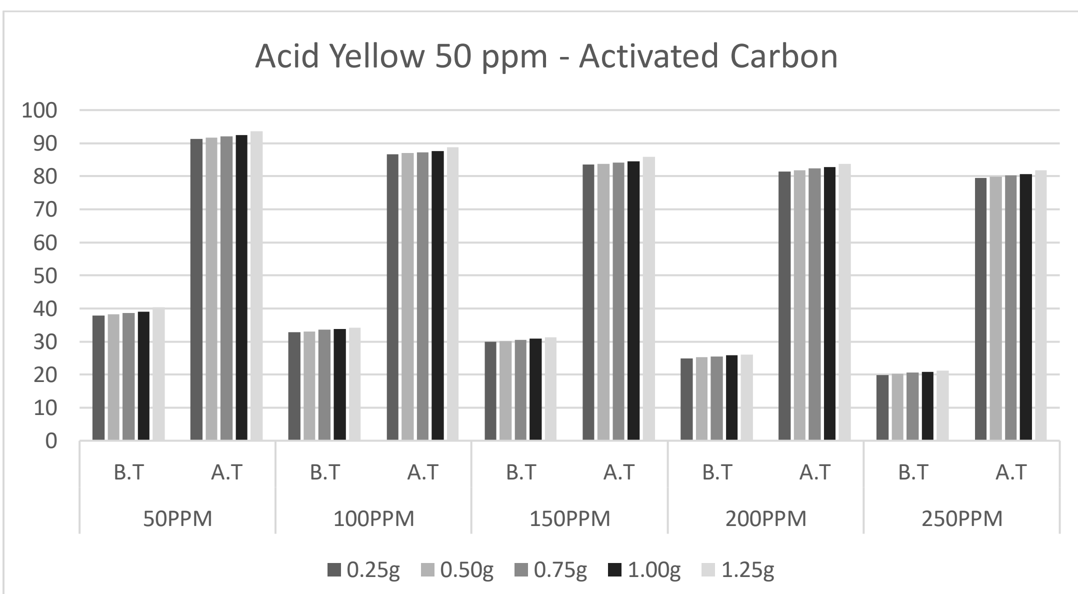
B14. Acid Yellow 11 (25 ppm) - Peanut Hull



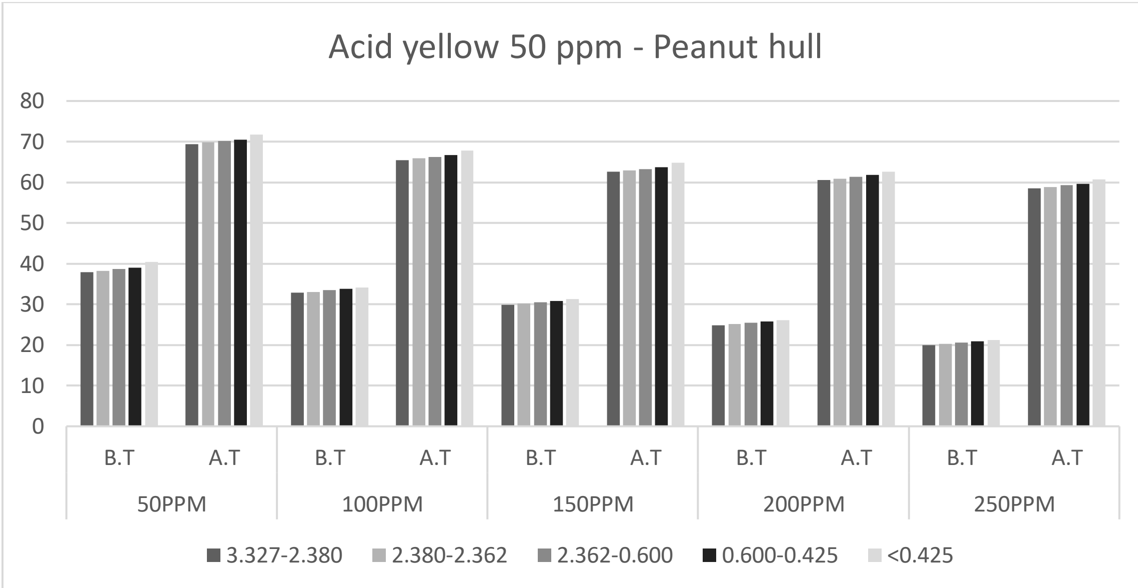
B15. Acid Yellow (25 ppm) - Banana Peel



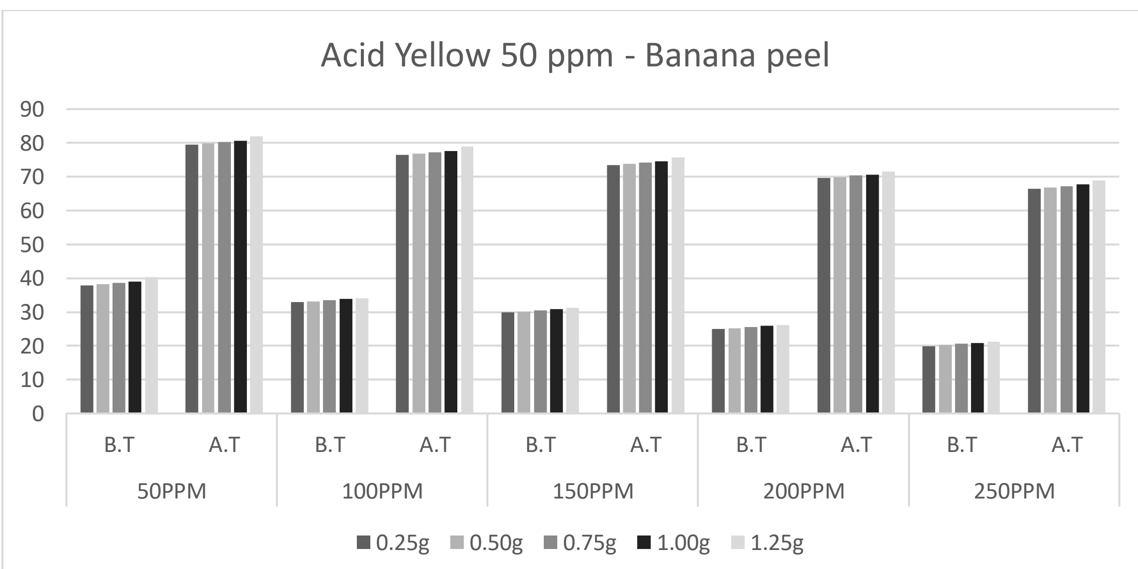
B16. Acid Yellow (50 ppm) - Activated Carbon



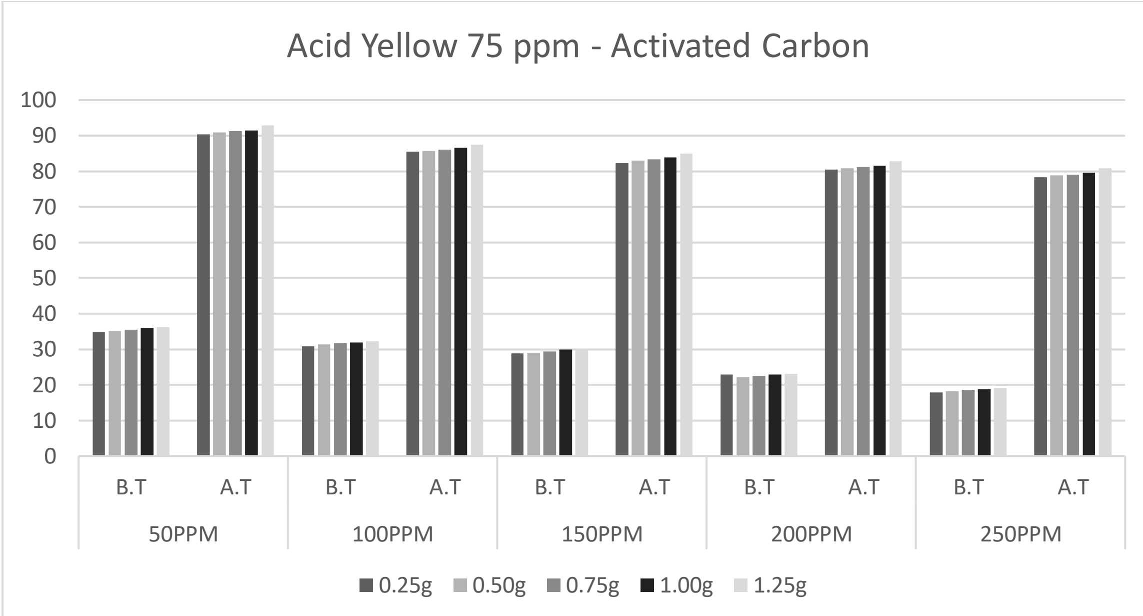
B17. Acid Yellow (50 ppm) - Peanut Hull



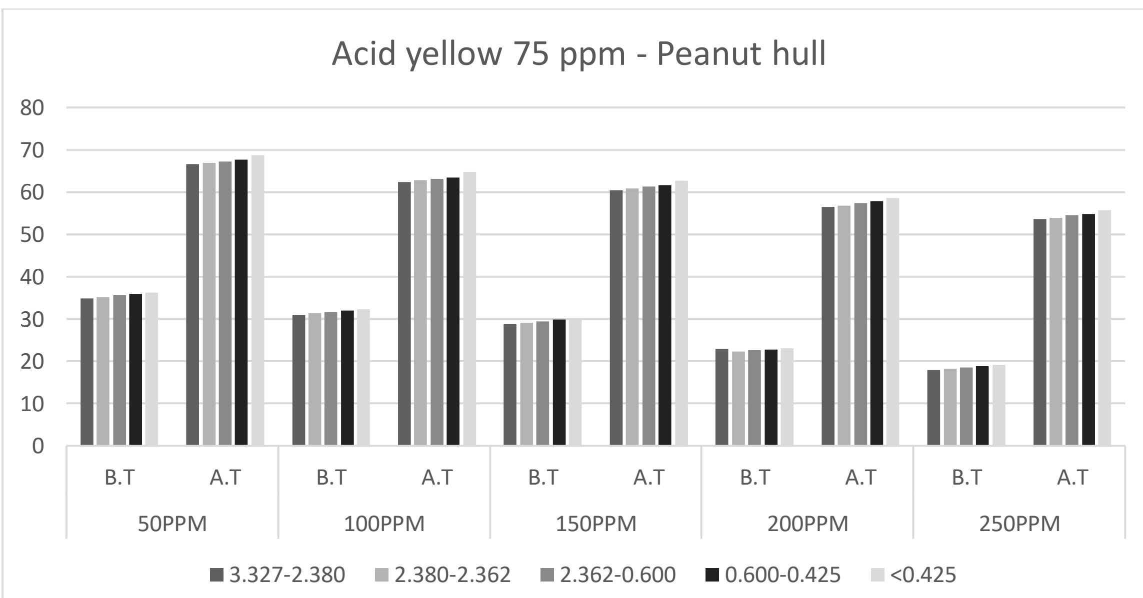
B18. Acid Yellow (50 ppm) - Banana Peel



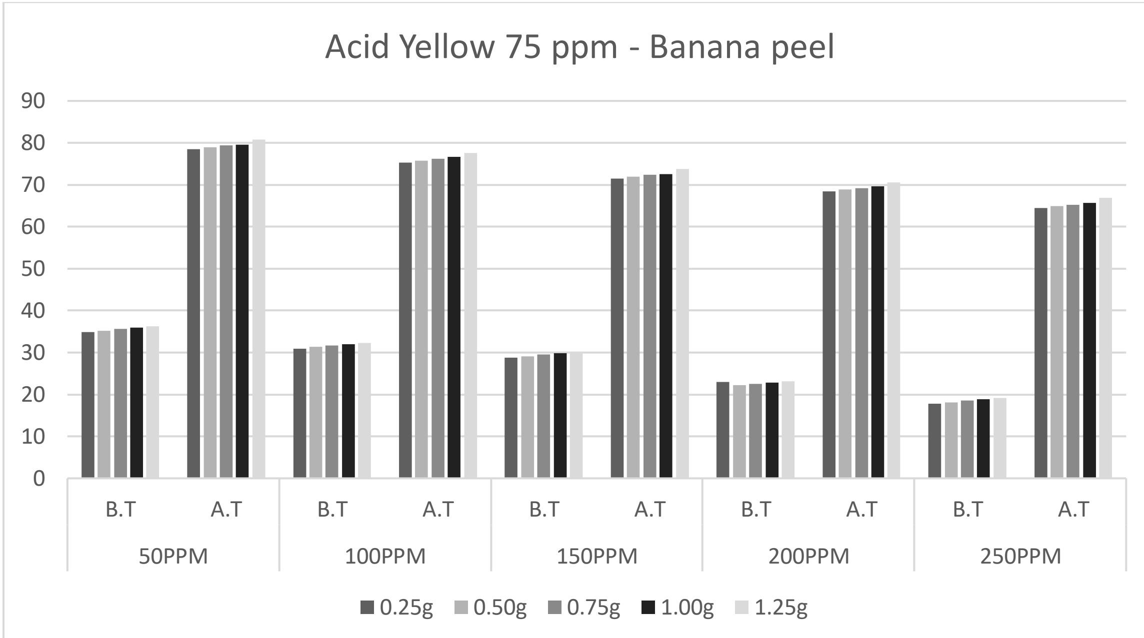
B19. Acid Yellow (75 ppm) - Activated Carbon



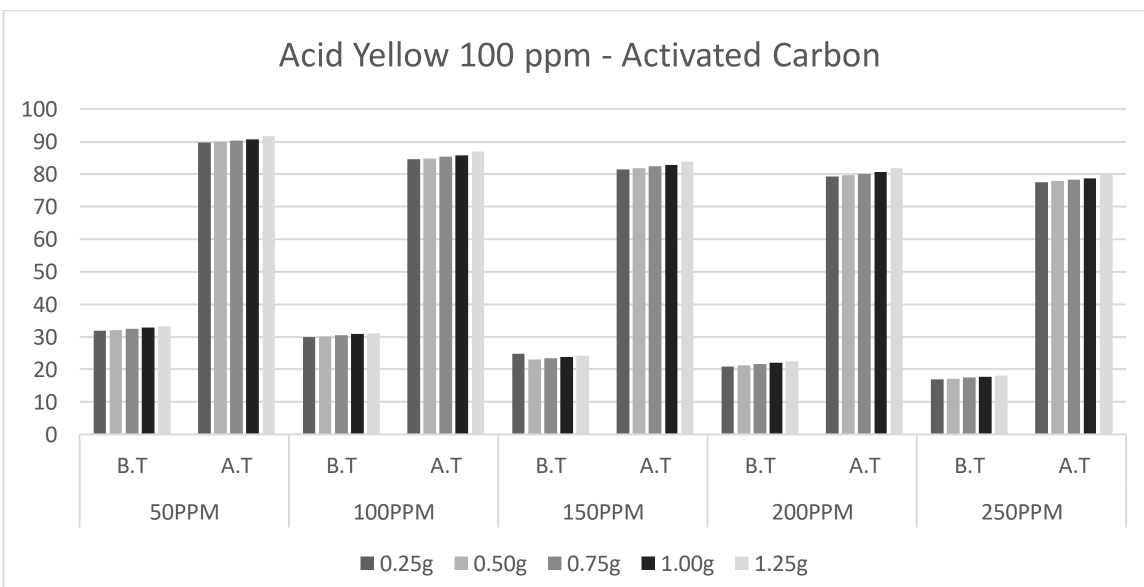
B20. Acid Yellow (75 ppm) - Peanut Hull



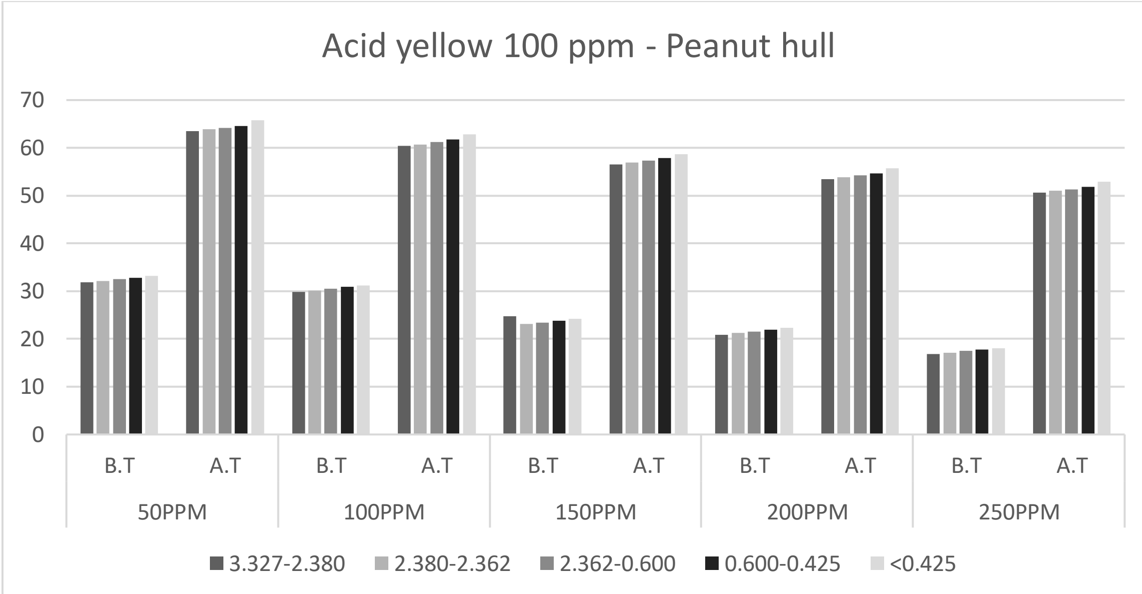
B21. Acid Yellow (75 ppm) - Banana Peel



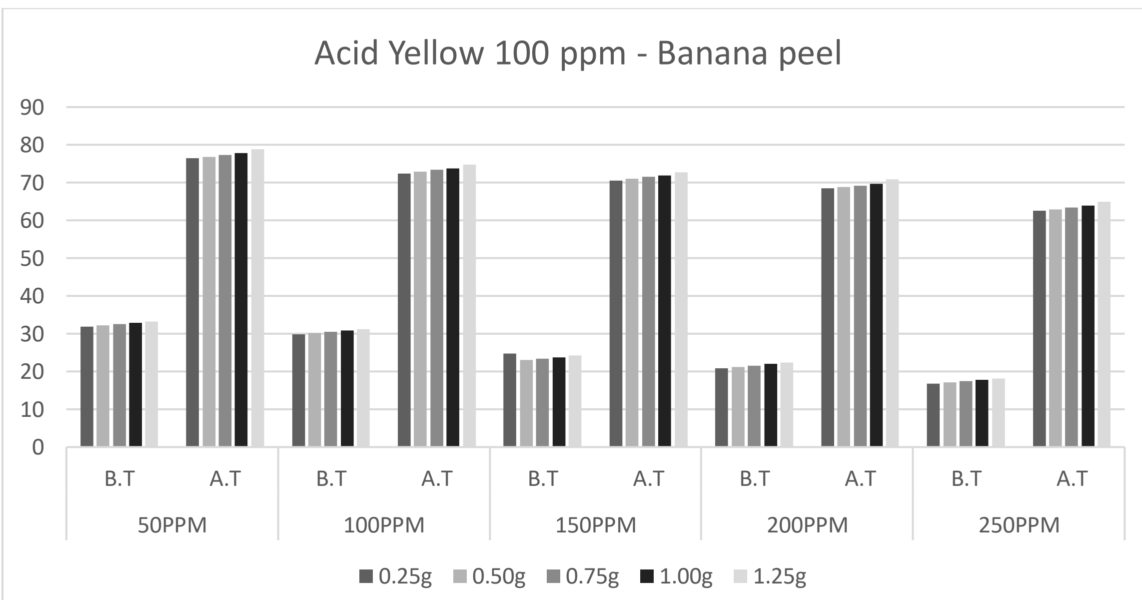
B22. Acid Yellow (100 ppm) - Activated Carbon



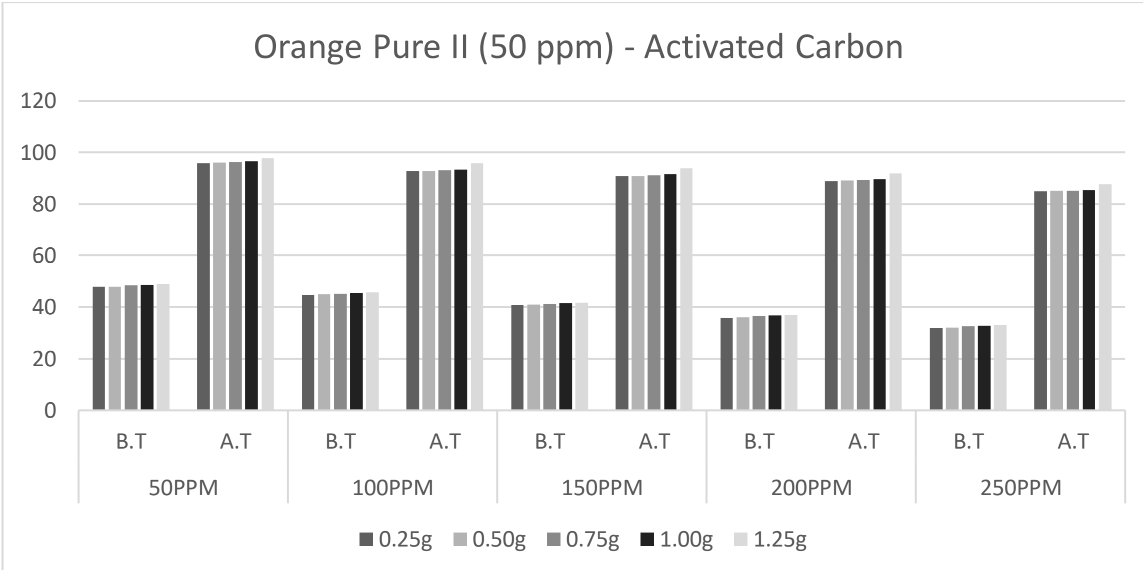
B23. Acid Yellow (100 ppm) - Peanut Hull



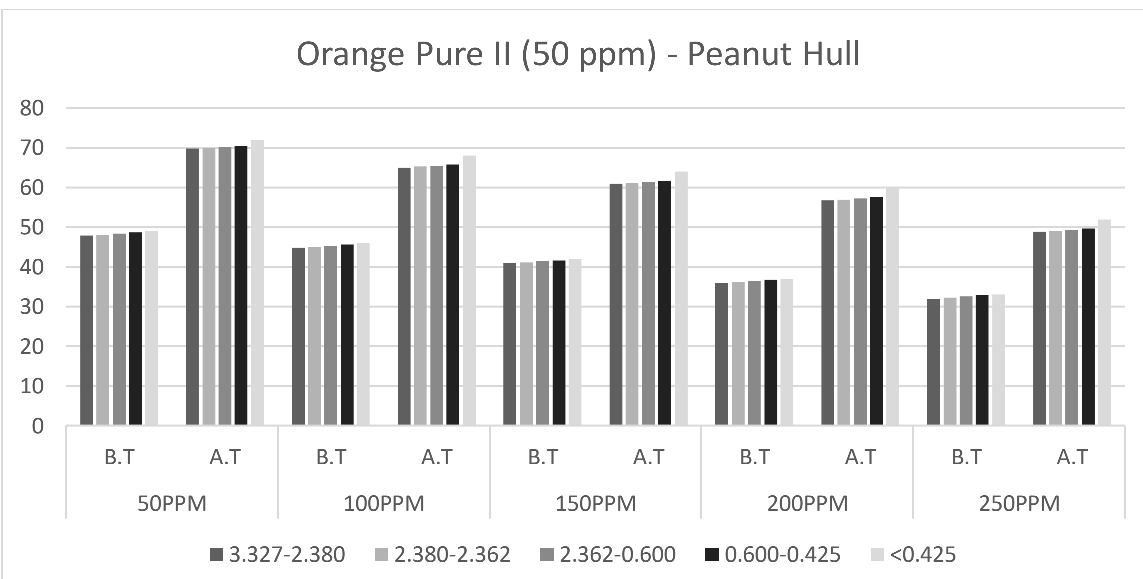
B24. Acid Yellow (100 ppm) - Banana Peel



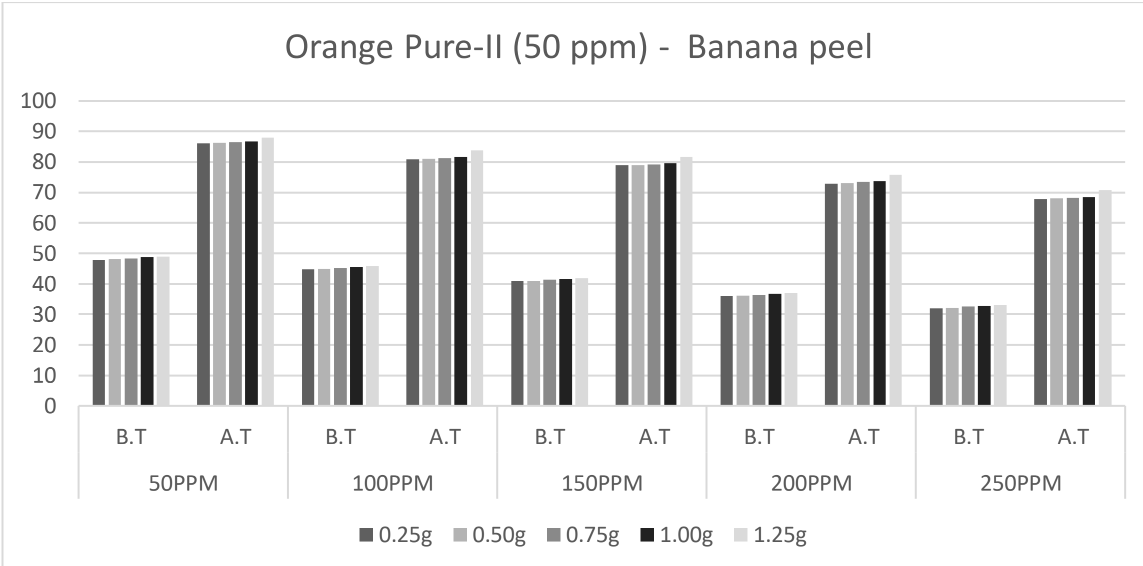
B25. Orange Pure II (50 ppm) - Activated Carbon



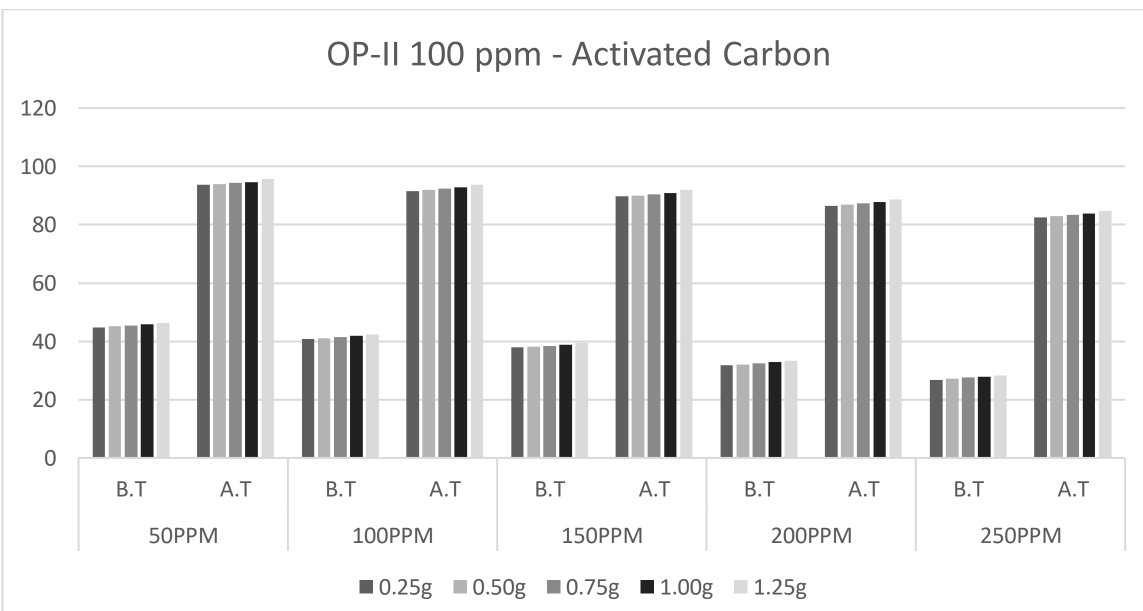
B26. Orange Pure II (50 ppm) - Peanut Hull



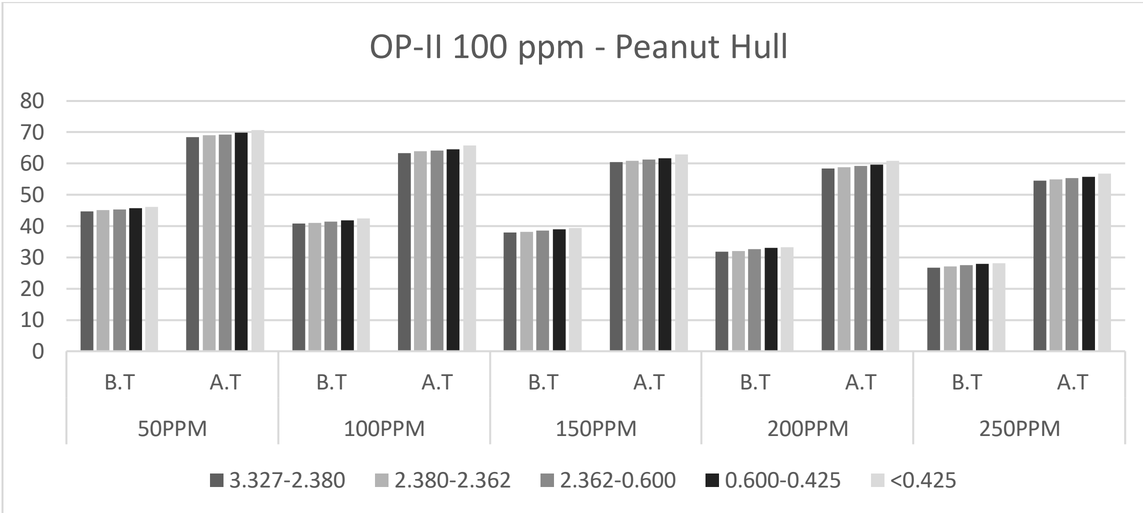
B27. Orange Pure II (50 ppm) - Banana Peel



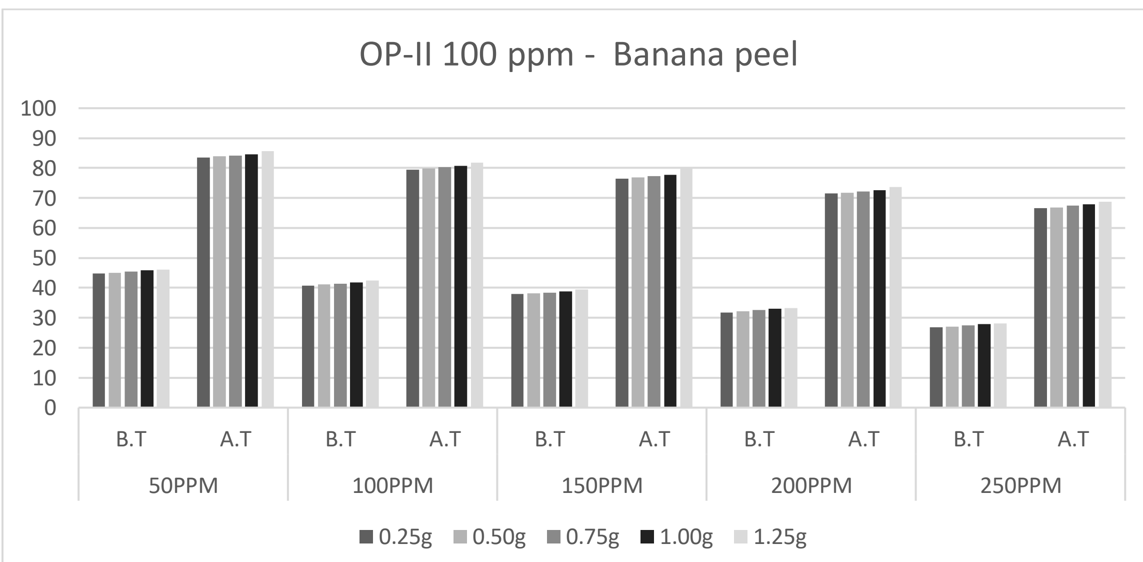
B28. Orange Pure II (100 ppm) - Activated Carbon



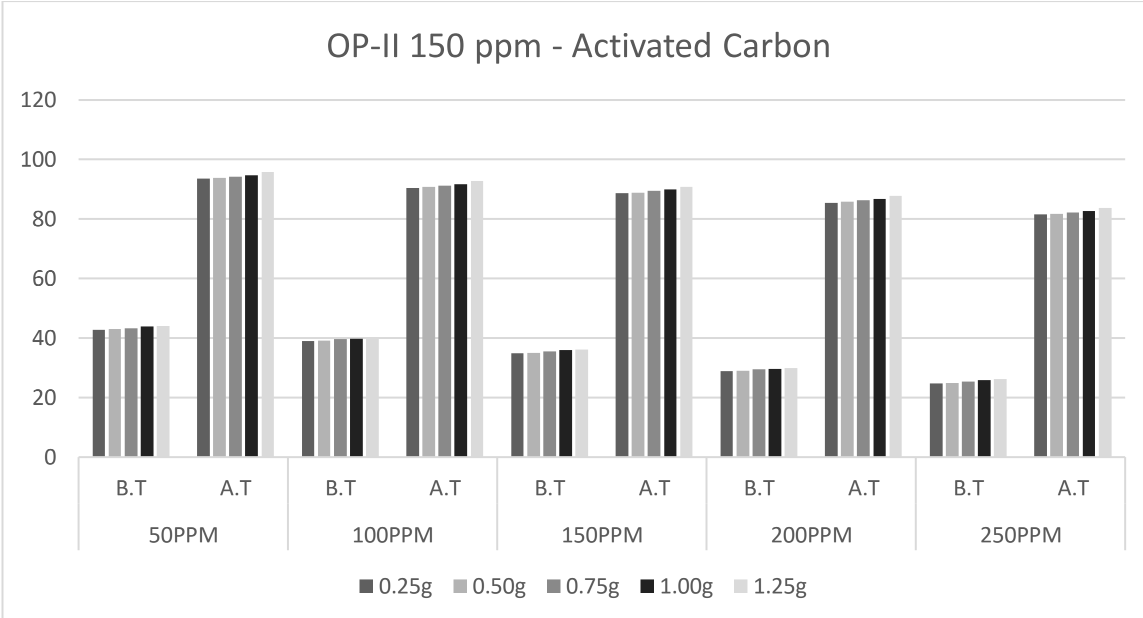
B29. Orange Pure II (100 ppm) - Peanut Hull



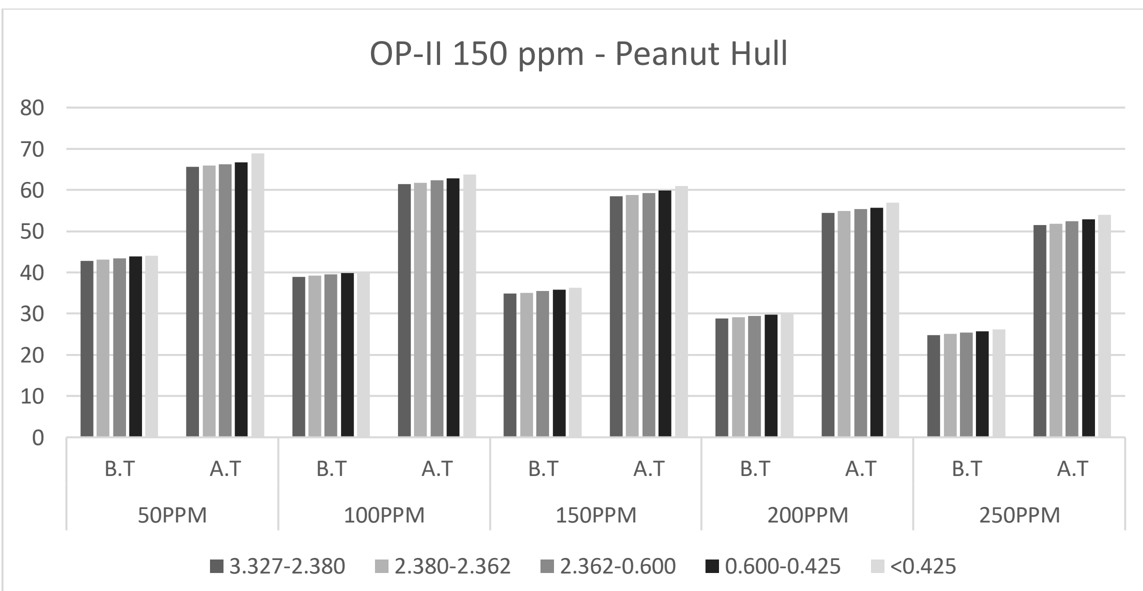
B30. Orange Pure II (100 ppm) - Banana Peel



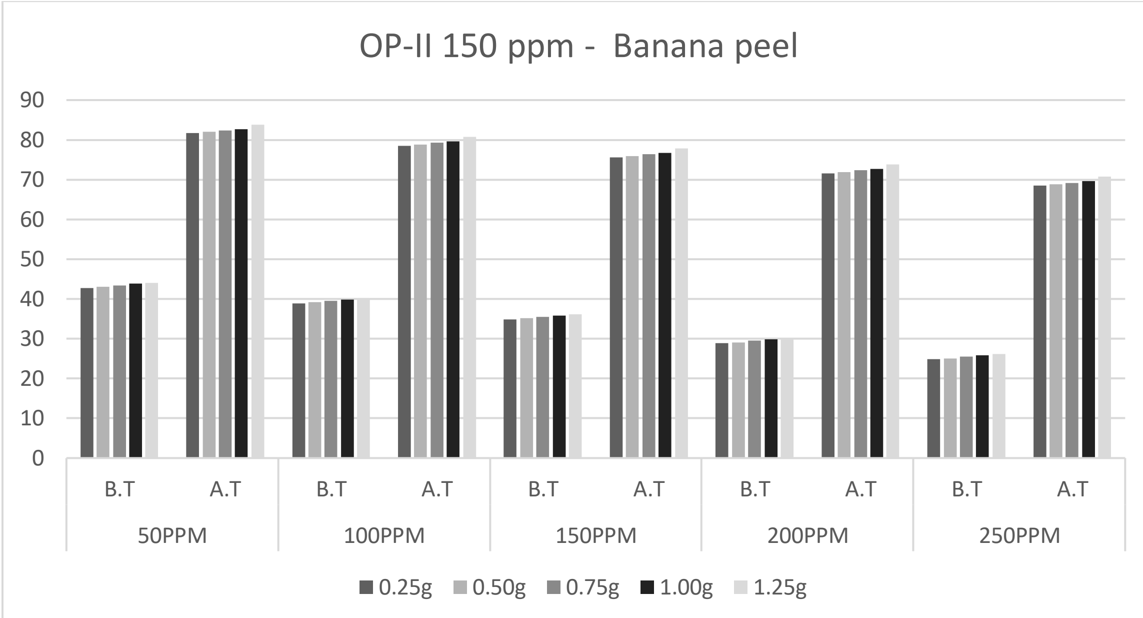
B31. Orange Pure II (150 ppm) - Activated Carbon



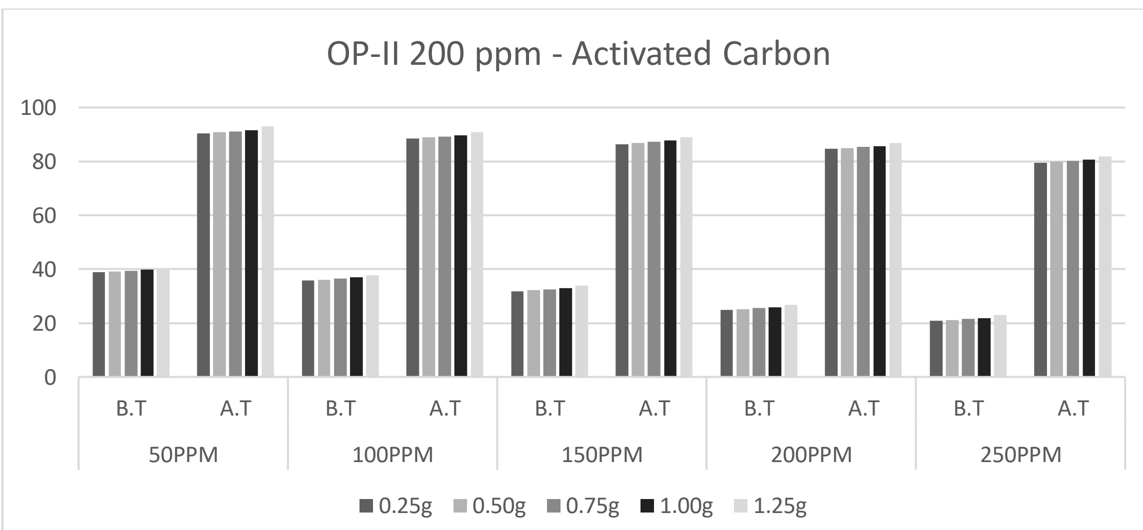
B32. Orange Pure II (150 ppm) - Peanut Hull



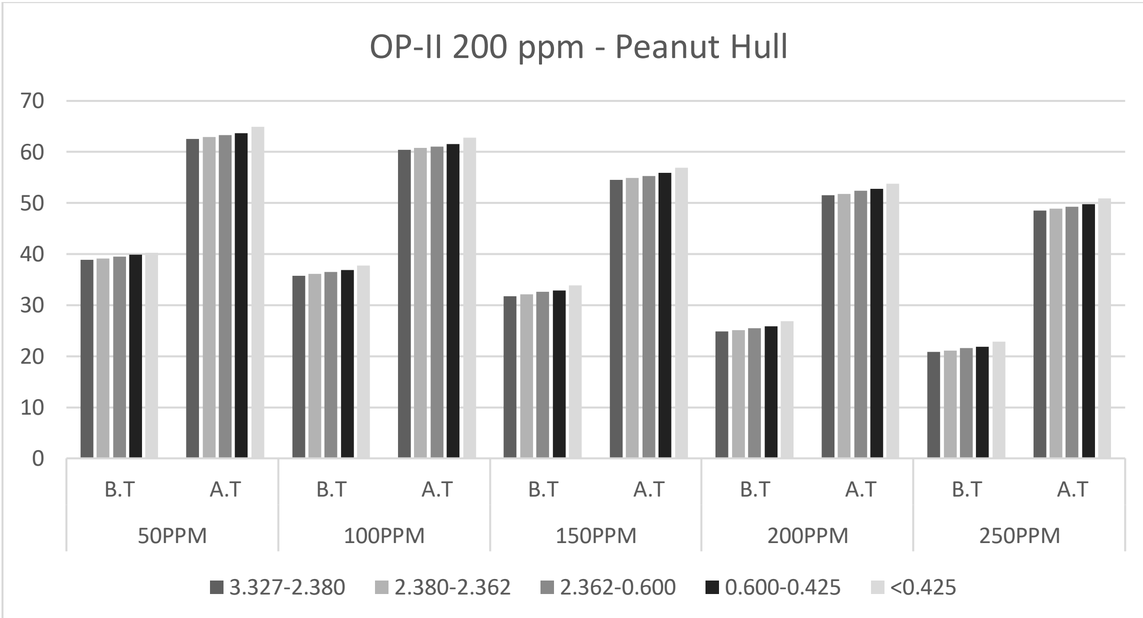
B33. Orange Pure II (150 ppm) - Banana Peel



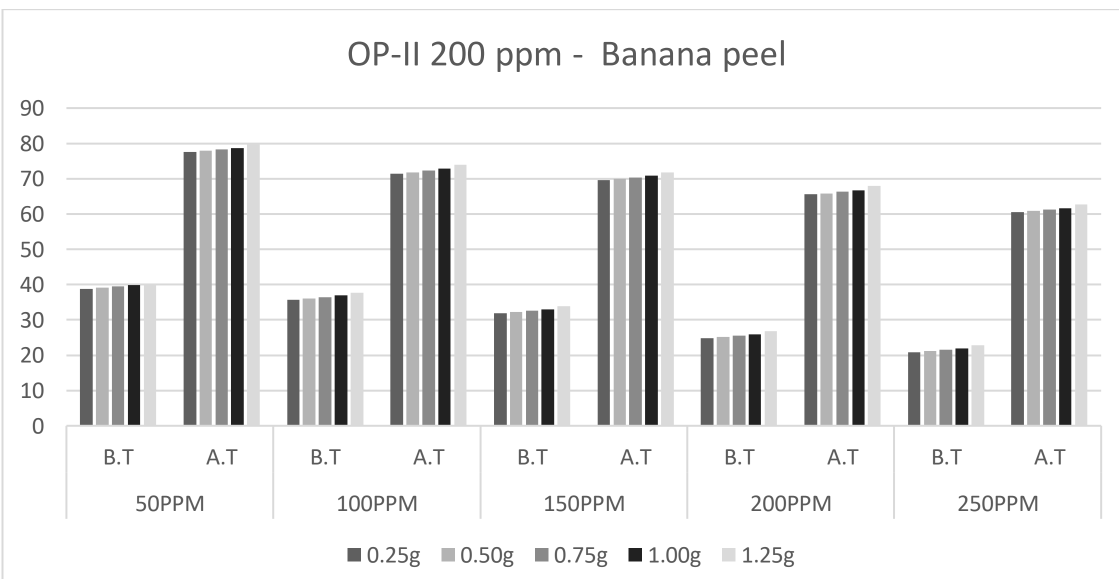
B34. Orange Pure II (200 ppm) - Activated Carbon



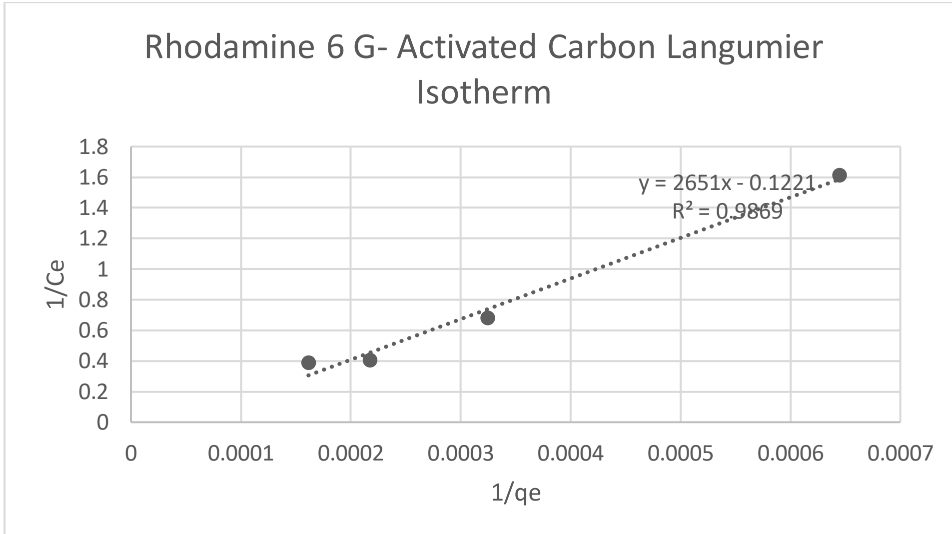
B35. Orange Pure II (200 ppm) - Peanut Hull



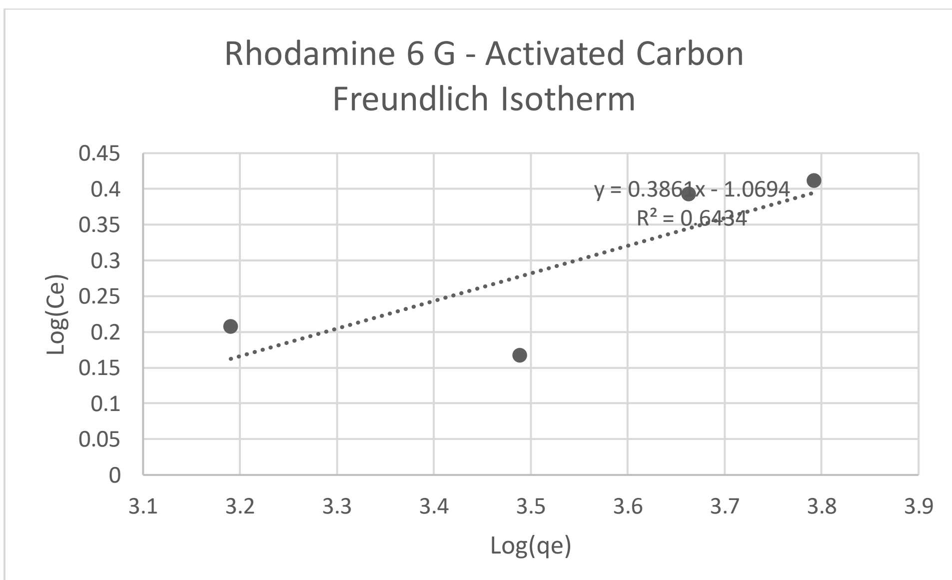
B36. Orange Pure II (200 ppm) - Banana Peel



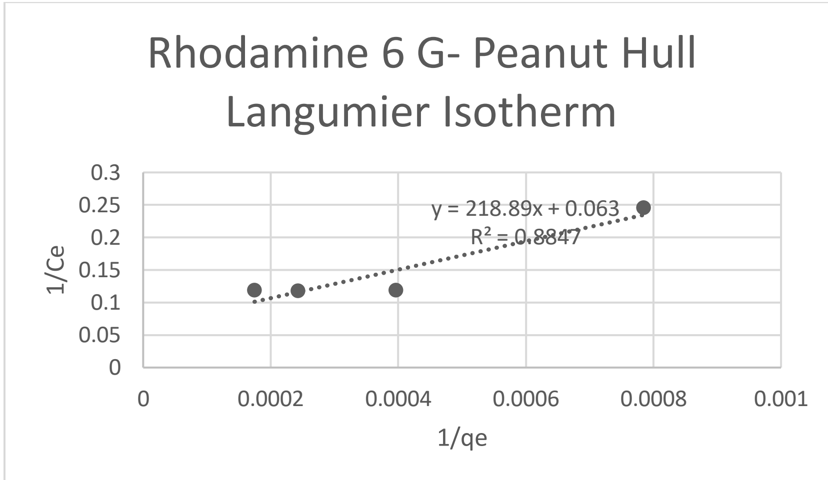
B37. Rhodamine 6 G – Activated Carbon – Langmuir Isotherm



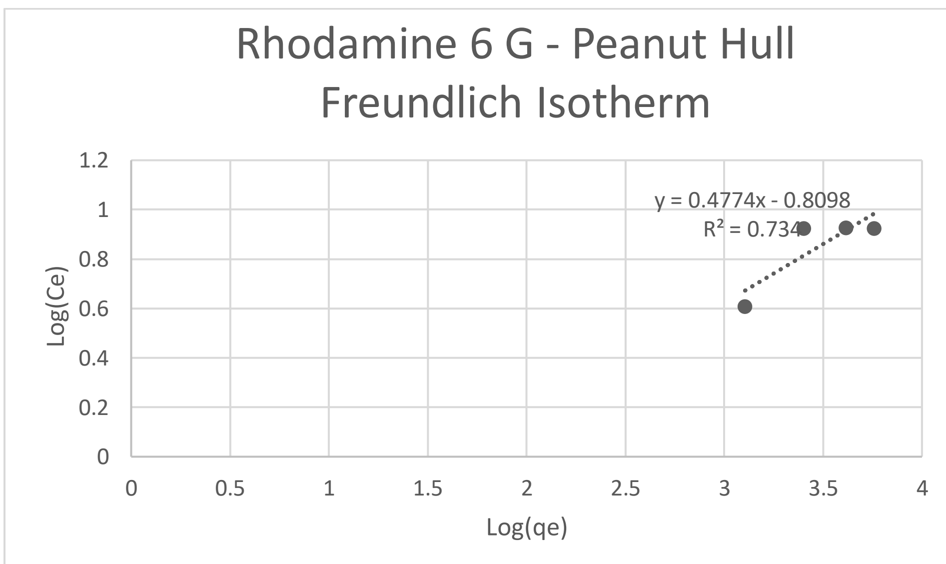
B38. Rhodamine 6 G – Activated Carbon – Freundlich Isotherm



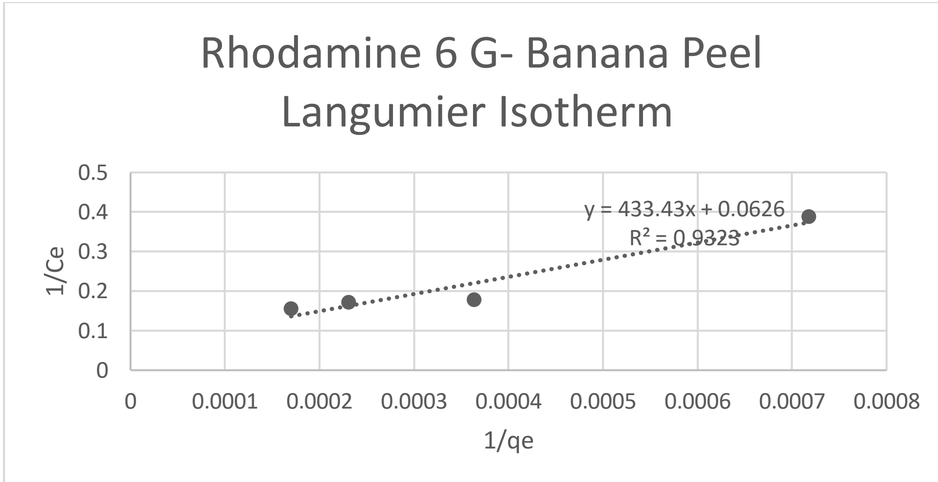
B39. Rhodamine 6 G – Peanut Hull – Langmuir Isotherm



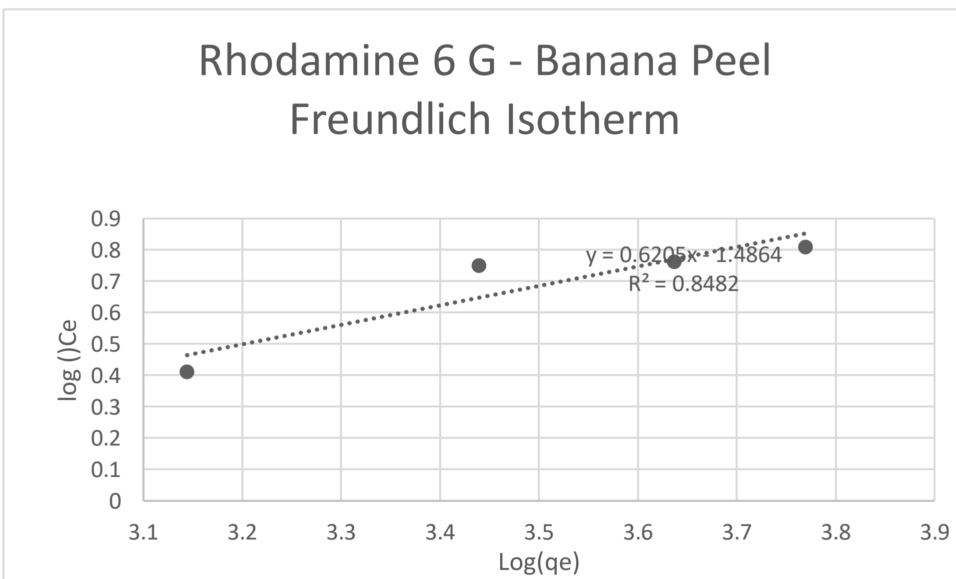
B40. Rhodamine 6 G – Peanut Hull – Freundlich Isotherm



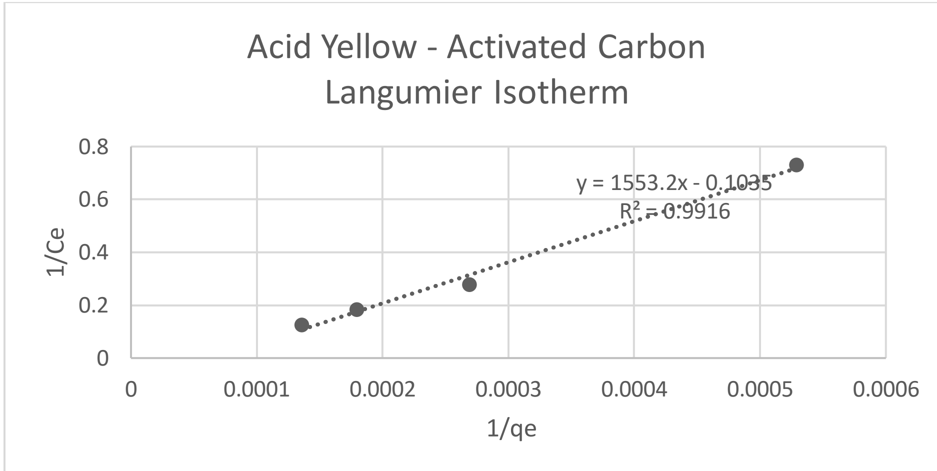
B41. Rhodamine 6 G – Banana Peel – Langmuir Isotherm



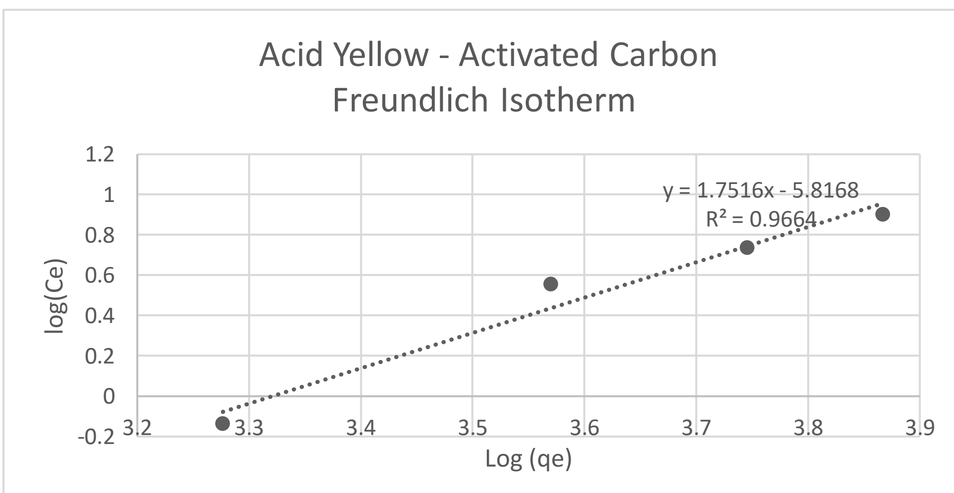
B42. Rhodamine 6 G – Banana Peel – Freundlich Isotherm



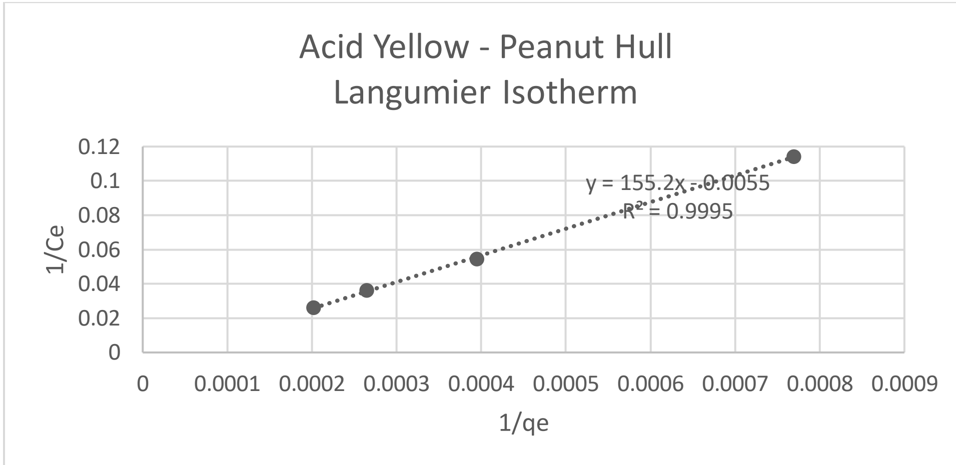
B43. Acid Yellow – Activated Carbon – Langmuir Isotherm



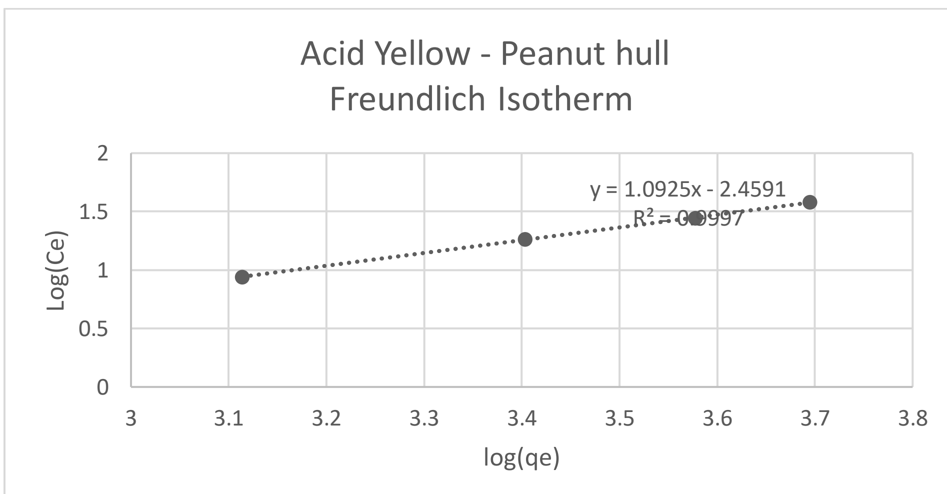
B44. Acid Yellow – Activated Carbon – Freundlich Isotherm



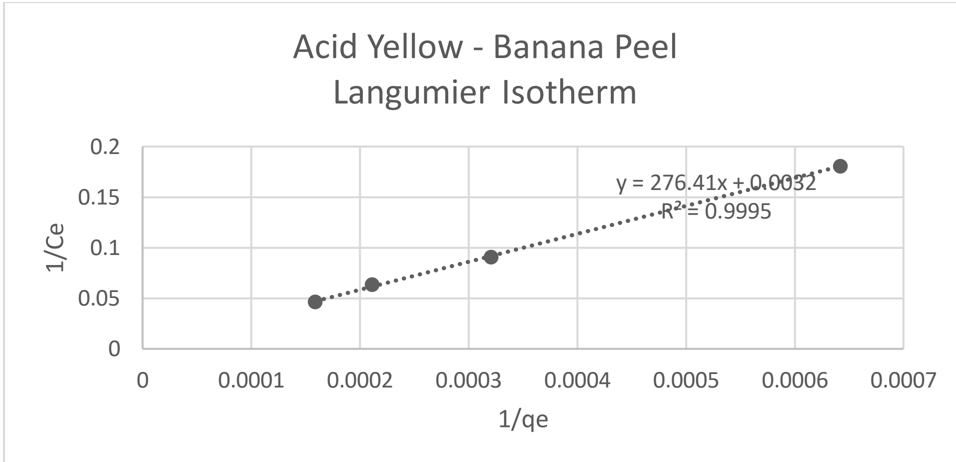
B45. Acid Yellow – Peanut Hull – Langmuir Isotherm



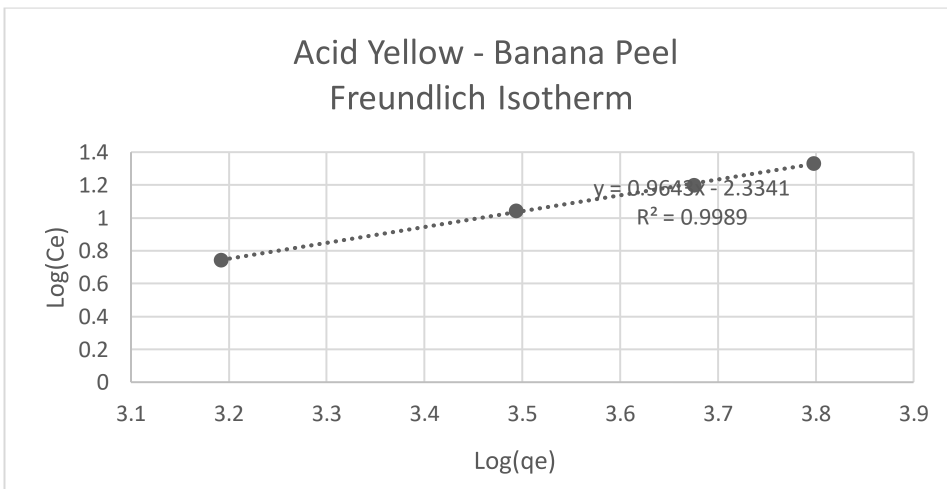
B46. Acid Yellow – Peanut Hull – Freundlich Isotherm



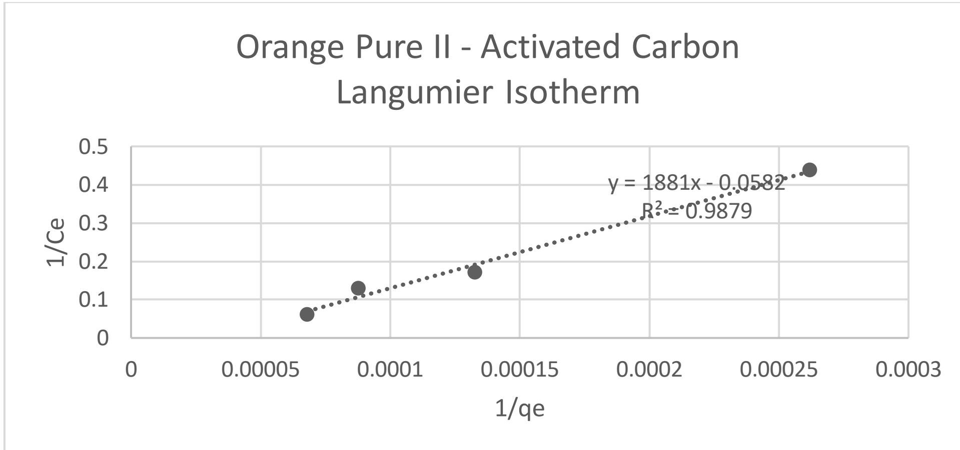
B47. Acid Yellow – Banana Peel – Langmuir Isotherm



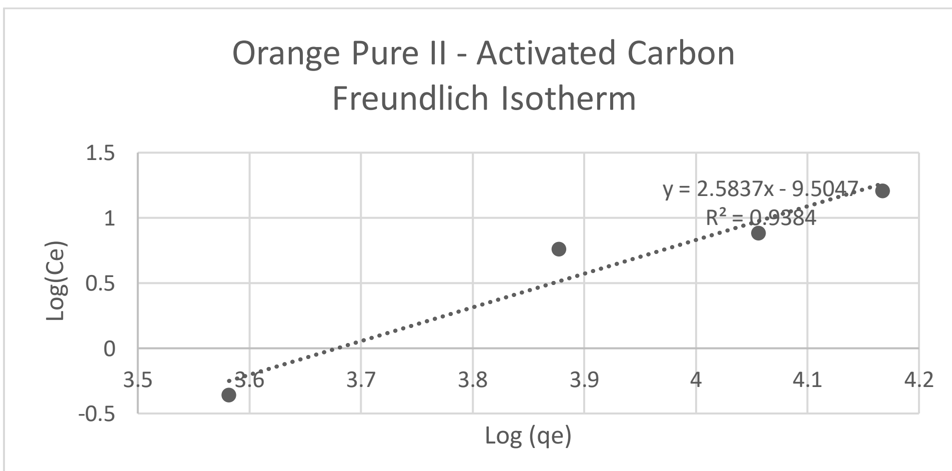
B48. Acid Yellow – Banana Peel – Freundlich Isotherm



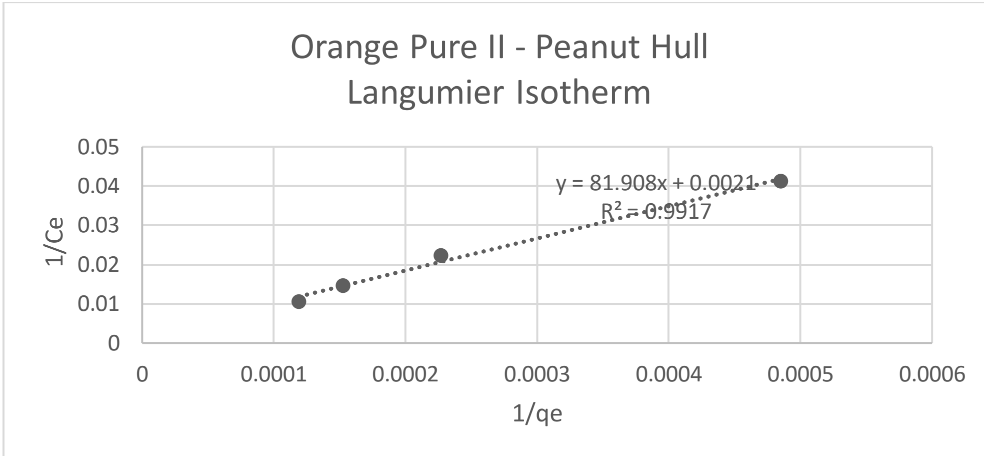
B49. Orange Pure II – Activated Carbon – Langmuir Isotherm



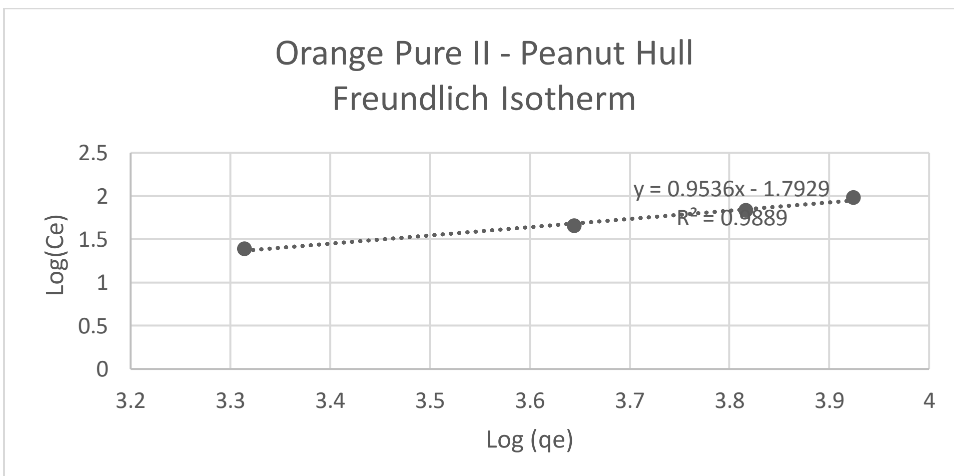
B50. Orange Pure II – Activated Carbon – Freundlich Isotherm



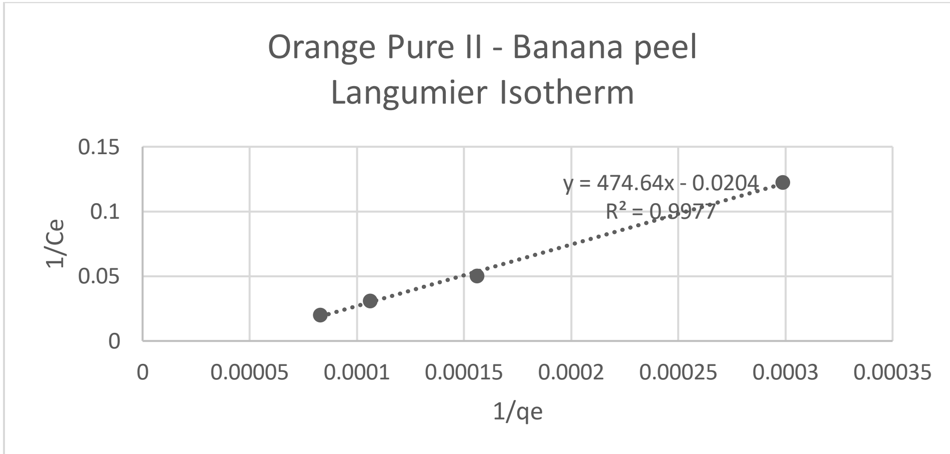
B51. Orange Pure II – Peanut Hull – Langmuir Isotherm



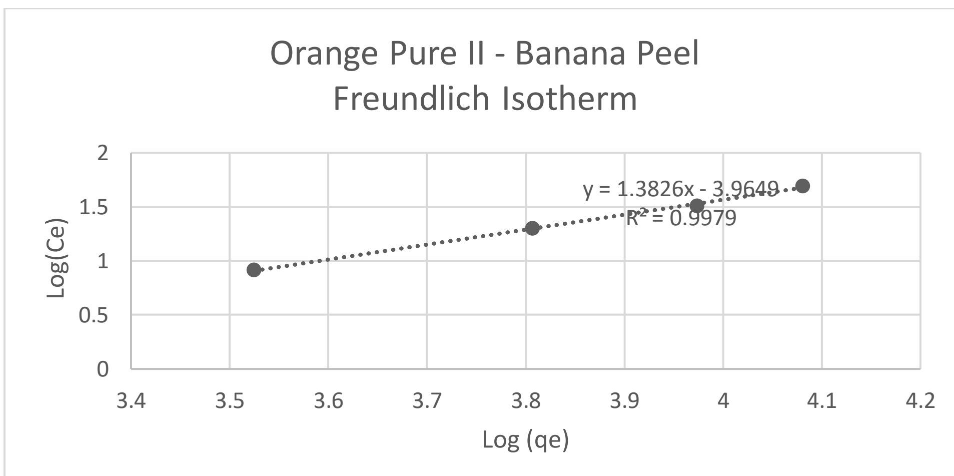
B52. Orange Pure II – Peanut Hull – Freundlich Isotherm



B53. Orange Pure II – Banana Peel – Langmuir Isotherm



B54. Orange Pure II – Banana Peel – Freundlich Isotherm



B55. Effect of pH on combined Dye and Milk wastewater with varying adsorbents at optimum dosage