CHAPTER I

INTRODUCTION

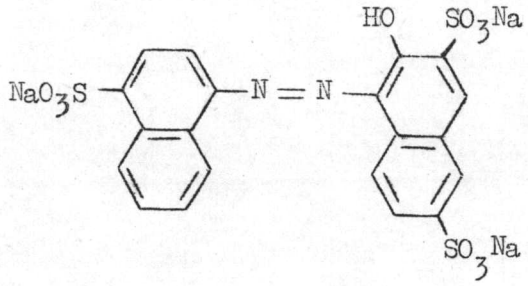
Food colors used as food additives are natural and synthetic products. Natural colors have been used in food over a long period of time and have been accepted for such use without any toxicological evidence supported as vegetables and cereal products. In considering such food colors, there are problems owing to the lack of information relating to the adequate identification and chemical composition. It was noted that natural colors may be available in different forms. The nature and proportions of the colors and other components of the same plant species may vary widely because of the differences in soil, climatic conditions, age of plant and time of harvest (1).

There are many groups of synthetic colors. Azo dyes and pigments are the largest one and are important in almost every type of applications (2). The common structural unit is the azo chromophore -N=N-, linking two carbons system at least one of which is aromatic (3).

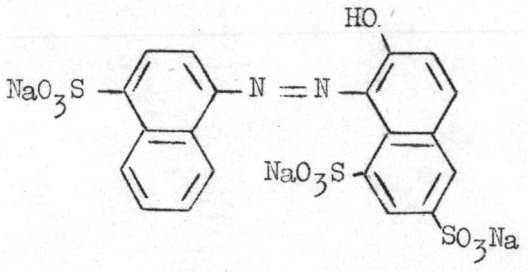
Azo dyes are synthesized almost exclusively by diazotization of a primary aromatic amine to give a diazo or diazonium salt. The diazo compound is then coupled with a second substance, usually a phenol, an enolizable ketone, or an aromatic amine.

Azo dyes have a wide range of colors (2). Azo compounds are carcinogenic (1,4), however, some of them are still being used

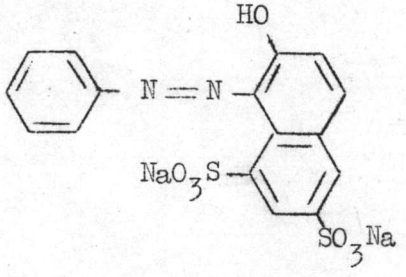
as food additives. Monoazo dyes are of interest by this study since they contain only one azo unit which makes the study of electron transfer mechanism simple. The dyes studied are Amaranth, Ponceau 4R, Orange G, Orange RN and Sunset Yellow FCF. They are organic synthetic dyes and their structural formulas are shown below.



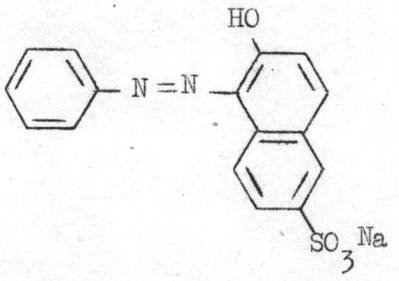
Amaranth



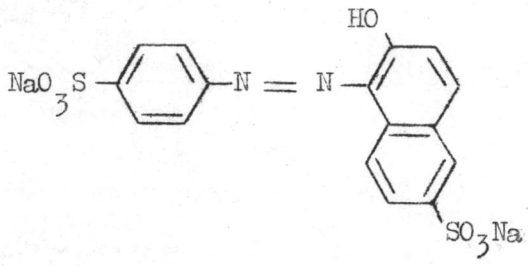
Ponceau 4R



Orange G



Orange RN



Sunset Yellow FCF

These dyes were selected for the present study since they all have similar structures. They are different in substituted groups. The uses of Amaranth and Orange RN were terminated since 1977 but Ponceau 4R and Sunset Yellow FCF are still permitted to use (5,6,7).

Generally the metabolic mechanisms of these dyes in human body are largely electron transfer processes and the polarographic reductions of these dyes were performed by the present study for this reason.

Amaranth and Ponceau 4R are red dyes but Orange RN, Orange G and Sunset Yellow FCF are orange dyes. They are acidic dyes of monoazo series and water soluble food colors (8). They are sparingly soluble in 95% alcohol but easily soluble in the glycols and glycerol. Pure grades of the dyes are used for food, drugs and cosmetics. In industries, they are used for the surface coating of paper, the dyeing of leather and preparation of wood stains. They are also used in the biological microtechnique as a stain for cell and tissue substances (9). Biochemical studies of Amaranth, Sunset Yellow FCF, Orange RN and Orange G in rats showed that the major portions of the colors were reduced at the azo-linkage by intestinal bacteria (1). Amaranth and Ponceau 4R have strong affinities for protein materials but they uncolored or slightly stained cellulose and cellulose acetate (9).

Amaranth is used as an indicator in hydrazine titrations and in color photography(9). It is prepared by coupling the diazotized 1-naphthyl amine-4-sulfonic acid with 2-naphthol-3, 6-disulfonic acid (10). The estimation of acceptable daily intake of the color for man is 0-1.5 mg/kg body weight (1).

Orange G is prepared by coupling benzenediazonium chloride with 2-naphthol -6, 8-disulfonic acid (10).

Sunset Yellow FCF is prepared by coupling the diazotized sulfanilic acid with 2-naphthol-6-sulfonic acid. The estimation of acceptable daily intake for man of Sunset Yellow FCF is 0-5.0 mg/kg body-weight (1).

Orange RN was commented on the lack of evidence for the safety by the Food Standards Committee and the Joint FAO/WHO Expert Committee on Food Additives (7). When the azo linkage of Orange RN is broken the metabolites identified are 1-amino-2-naphthol 6-sulfonic acid, aniline, p-aminophenol and O-aminophenol. These metabolites are capable of producing Heinz body and the associated haemolytic anemia (7). The consideration of Orange G which has a similar structure as Orange RN was suggested the likely effect of Orange RN (7).

There were only a few studies on polarographic behaviors of azo compounds. The reduction of azobenzene which is the simple aromatic azo compound was reported to be a 2-electron electrode reaction to hydrazobenzene (11). However, when the strongly-releasing substituent groups, such as p-OH or p-NH_2, are present, the hydrazo derivative is unstable and a single 4-electron wave may result (12,13). Florence (14) had studied the polarographic behaviors of a wide range

of heterocyclic azo compounds and their metal complexes. The hydrazo derivatives of the heterocyclic dyes are more stable with respect to disproportionation, which is attributed to the strongly electron-attracting properties of the pyridyl and thiazolyl groups. Florence (12,13,15) had also investigated the polarographic behaviors of aromatic azo dyes. The para-substituted groups, such as hydroxy, amino and dimethylamino, can cause a number of electrons involved in the polarographic reduction to increase from two to four. Polarographic reductions of solochrome mordant azo dyes were found to give diffusion controlled irreversible waves (16). A detailed mechanism including the effect of substituents on the half wave potentials of these dyes had also been suggested. The polarographic behaviors of some azo food colors were suggested to be the 2-electron transferred reduction process (17,18).

This investigation is intended as a polarographic study of the electron transfer mechanisms of Amaranth, Ponceau 4R, Orange G, Orange RN and Sunset Yellow FCF in order to suggest the intermediate or product formed in the reduction process. Paper chromatographic and visible-ultraviolet spectrophotometric techniques were used to examine the purities of the food colors and were also used to identify food dyes in some beverages. Quantitative analyses of food dyes in some beverages were reported.