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Food Additives Law and Practice

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A DECISION of the United States Supreme Court on Dec. 15, 1958, interpreting the Federal Food Drug & Cosmetic Act, has focused attention on the use of coloring and other materials in foods, drugs and cosmetics.[1] This requires a complex study of the effects of the various food additives, contaminants and chemicals upon the individual, whether intentionally added or accidently produced, in foods, drugs and cosmetics.

Evaluation of the tremendous group of food additives can best be approached in the light of the benefits intended by the manufacturer or grower using them.

1. *Nutrient Supplements*—Vitamins and minerals are added to foods to improve nutritive value and at times to reduce those removed in the processing. For example—thiamin, riboflavin, niacin and iron may be added to bread. Other foods to which nutrients are commonly added are flour and noodle products.

2. *Non-nutritive* sweeteners include saccharin and calcium and sodium cyclamates.

3. *Preservatives*—There are many different types of preservatives, each type being best suited to a particular type of product or against a particular spoilage organism or chemical change. The preservatives in bread are called mold or rope inhibitors. Those permitted in bread include sodium and calcium propionate, lactic acid, and acetic acid. Antimyotics prevent the molding of citrus fruits. Another type of preservative prevents physical or chemical changes which affect color, flavor, texture or appearance. These are called sequestrants. Other common preservatives are benzoic acid, sodium benzoate and sulphur dioxide. Special note should be made of the March 24, 1959 tragic incident

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[1] Flemming v. Florida Citrus Exchange, 79 S. Ct. 160 (decided Dec. 1958; reported Jan. 1959), revg. 246 F. 2d 850 (C. A. 5); cf., Fed. Food, Drug & Cosmetic Act; 21 U. S. C. A. Secs. 342 (a) (1, 2), 346 (a). But by Feb. 9 the Senate already had sent to the House a bill permitting 2 year use of Coal Tar Citrus Red No. 2 (safer than F. D. & C. Red No. 32) sponsored by Senator S. L. Holland of Florida. See 4 N. C. S. (12) 91 (Mar. 15, 1959).

A new amendment to F. D. & C. Act became effective on March 5, 1959, setting up a new system of public protection described below. See also Symposium on Product Liabilty, 8 Clev-Mar. L. R. (1) (Jan. 1959).

in which a child in Haddon Heights, New Jersey died from the consumption of fish which had been treated with large quantities of sodium nitrite as a preservative.

4. *Emulsifiers* affect characteristics such as volume, uniformity, fineness of grain (bakery goods), smoothness of dairy products, and homogeneity and keeping quality of confectionery. Some common emulsifiers are lecithin and propylene glycol.

5. *Stabilizers and Thickeners*—Smoothness of texture of ice cream, uniformity of color, flavor and viscosity of chocolate milk, and homogenizations of fruit juices are typical purposes of stabilizer chemicals such as pectins, gelatin and agar agar.

6. *Acids, Alkalies, buffers, neutralizing agents*—The degree of acidity or alkalinity is important in many processed foods. The taste of soft drinks is largely due to organic acids.

7. *Flavoring Agents*—Typical of synthetic flavors used in such products as soft drinks, bakery goods, ice cream are chemicals such as amyl acetate, benzaldehyde, methyl salicylate. Essential oils such as oil of orange and oil of lemon are extracted from the fruit rind.

8. *Bleaching Agents and Bread Improvers*—Freshly milled flour is yellowish and makes a poor dough. The aging and bleaching of flour can be speeded up by adding oxidizing chemicals such as chlorine dioxide, benzoyl, peroxide and nitrosyl chloride. Dough conditioners include ammonium chloride, calcium sulfate and calcium phosphate.

9. *Pesticides*—Modern pesticides are an important factor in the plentiful supply of food. Some of these agricultural chemicals remain on the fruits or vegetables when they are harvested. Practically all are injurious to humans or animals when ingested or contacted in excessive amounts. The residues remaining on or in foods at harvest add to the peril of the original amount of pesticide used. Legal restrictions on the use of pesticides in food production are provided for by the Federal Food and Drug & Cosmetic Act of 1938 as amended in 1954 by Public Law 518 and in 1956 by Public Law 905 and the Federal Insecticide, Fungicide and Rodenticide Act of 1947. The Miller Amendment of 1954 establishes a procedure for setting safe limits or tolerances for residues of pesticides which may remain on fresh vegetables and fruits when shipped.

10. *Coal-Tar colors*—Synthetic colors, called coal-tar colors because they were originally made from chemicals obtained from

coal-tars, are subject to special provisions of the law. Every such color used must be on a list of colors regarded by the Federal Drug Administration as harmless and suitable for use, and every batch of color made must be listed for purity in F. D. A. laboratories (see the footnote to the opening paragraph above).

To realize the dangers and problems of color additives it is significant to review the chronology of the development and consequences of coal-tar colors.

Chronology of Developments on Coal-Tar Colors

1856: The first synthetic color was produced in England. Other synthetic colors followed rapidly and soon appeared in food.

1886: The United States Congress passed a law that authorized the addition of coloring matter to butter.

1896: The United States Congress passed a law that recognized coloring matter as a legitimate constituent of cheese.

1906: The original Pure Food and Drug law was enacted. The regulations issued under it provided that only harmless colors could be used in food products.

1907: By this year a special administrative procedure was developed to safeguard colored food. Seven colors were listed as suitable for use in food, provided they were pure enough; each batch of color had to be tested by competent experts and found to be non-toxic and free from harmful constituents. (A few other colors were added to the list later.)

1938: A more modern pure food and drug law was enacted (the Federal Food, Drug and Cosmetic Act). It reaffirmed the national policy of allowing synthetic colors in food, subject to safeguards considered necessary to protect the public health and prevent deception of consumers. It gave legislative sanction to the established administrative practice of listing certain colors for use in food and required that each batch of listed colors be tested by the Food and Drug Administration for purity before it could be marketed.

While in 1938 Congress recognized that most coal-tar colors were toxic, such as those used to dye cloth or make paint, it thought an adequate supply of harmless colors had been developed under the administrative practice of the preceding 30 years and presumably could continue to be developed as needed. So Congress provided in the law that if a coal-tar color is harm-

less, it may be used in food without limitation; that if the color is itself a toxic substance, F. D. A. must decline to permit any amount of it in food. There was no middle ground that allowed F. D. A. to establish a safe level of use for a coal-tar color. Similarly, coal-tar colors may be used in drugs and cosmetics only if harmless.

1939: After public hearings, 17 food colors were listed as harmless and suitable for use in food. (Two more were added later.)

1950: The need for further studies became apparent when some children became ill of an unusually high concentration of a permitted orange dye (FD&C Orange No. 1) in Halloween candy. Using newer pharmacological procedures, F. D. A. started new tests on the food colors.

1953: The testing showed that FD&C Colors Red No. 32, Orange No. 1, and Orange No. 2 were not harmless.

December 15, 1953, to November 10, 1955: The Secretary of Health, Education, and Welfare issued a Notice of Hearing to amend the color certification regulations by deleting these three colors from the food list. The hearing was held in January 1954; the time for filing briefs on the hearing was extended at industry's request; and on December 22, 1954, the Secretary issued a notice of proposed expurgating of the three colors. The time for filing exceptions and briefs was extended, in January 1955, at industry's request. On November 10, 1955, the Secretary issued a final order removing the colors from the group permitted in food. Meanwhile, there were other developments having a significant bearing on this entire question:

June 1955: A Citizens Advisory Committee, appointed by the Secretary of Health, Education, and Welfare, recommended that the Department arrange for a review of F. D. A.'s research program on certified dyes to determine whether it was in the interest of public health.

Oct. 1955: Children became ill of a high concentration of FD&C Orange No. 1 in a popcorn confection, "Halloween Cats."

Dec. 1955: Nearly 200 people, mostly children, became ill of FD&C Red No. 32 after eating popcorn colored with the dye.

June 1956: A committee appointed by the National Research Council, in accordance with the recommendation of the Citizens Advisory Committee, having studied F. D. A.'s coal-tar

color research program, concluded that it was well chosen and included problems deserving of the highest priority. The Committee commented, however, that the present law is unrealistic with respect to coal-tar colors. It stated, "This Committee feels compelled to indicate that the certification of a compound as 'harmless and suitable for use' in foods, drugs and cosmetics, as required under the present law, is unrealistic unless the level of use is specified. Under a rigid interpretation of this directive, many components or ordinary diet could not be certified."

The Committee pointed out further that at the present rate, F. D. A.'s laboratories would require 25 years to complete the testing of all of the colors accepted for use in foods, drugs and cosmetics.

June 1956: Congress enacted a law which allowed FD&C Red No. 32 to be certified until March 1, 1959, solely for use in coloring the skins of oranges. The law was approved and became effective in July 1956. Since March 1, 1959, when the law expired, use of Red No. 32 on oranges was not legal.

Court Appeals on Red No. 32, Orange No. 1, and Orange No. 2

Feb. 1956: The coal-tar color industry committee appealed the delisting of the three colors to the U. S. Court of Appeals in New York (2d Circuit). This court found that the Secretary's action was taken in accordance with the law and should not be overruled.

The citrus industry challenged the Secretary's expurgating of Red No. 32 with respect to its use on oranges, by an appeal to the United States Court of Appeals in New Orleans (5th Circuit). This court found that the Secretary should certify the red color as harmless for use in coloring of oranges and found that the coloring of oranges is required.

Since the decisions of the two Circuit Courts were in conflict, the Government appealed the latter decision to the Supreme Court.

Dec. 1958: On December 15, 1958, the Supreme Court found that the Department's actions were proper. It reversed the decision of the 5th Circuit Court and held that the Department of Health, Education, and Welfare does not have the authority to issue tolerances for a coal-tar color that injures test animals when fed at the concentrations employed in FDA's experiments.[2]

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[2] See n. 1, above.

Actions with Respect to F&D Yellow Colors No. 1, 2, 3, and 4

January 1957 to January 1959: As soon as possible after starting the retesting of all food colors, these four yellow colors were fed to laboratory animals using the newer scientific procedures. By January 1957, the tests showed that they caused harm at feeding levels judged appropriate by F. D. A. scientists. F. D. A. published first a proposal and then an order removing the four yellows from the list of colors permitted in food. The color industry challenged the order and asked for a public hearing on it. The public hearing and the effectiveness of the order were held in abeyance until the decision of the Supreme Court in the case described above.

Unintentional contaminants and toxic chemicals may be added to food, drugs, and cosmetics through the process of preparing and packaging. A large number and variety of materials are required to meet all the functional needs of food and drug packages. They range from materials of simple composition, as for example a metal foil, to chemically complex synthetic films. The primary packaging materials such as metals, glass, wood, fabric, paper and synthetic films are modified in many ways for particular purposes. They may be treated to withstand the solvent action of acid, basic, neutral, alcoholic or fatty foods they will contain, or the abrasive action of the foods.

Discussion of the *metal containers* as a source of contamination is important. Metal containers are made of low carbon steel which is coated either with tin or with an organic film or both. The iron of plain cans may dissolve into foods in small quantities. Lead as a noxious chemical is derived from the solder used in the cans (solder containing 97% lead and 3% tin). Other components of the contamination of cans are obtained from the lubricants used, organic coatings, sealing compounds and side-seam cements.

Summary of Sources of Compounds

In summarizing the sources of food contaminants and additives the following is a panoramic view of the problem:

A listing of the main groups of food additives and contaminants which are intentionally or unintentionally introduced into foodstuffs to be used for human consumption includes a large

number of highly diverse chemicals and provides an illustration of the scope and type of problem to be dealt with.

A. *Food Additives*

1. Natural and synthetic dyes
2. Antioxidants of fats and liquids and vegetable matter
   (a) Destroyers of peroxides formed during auto-oxidation
   (b) Oxygen Acceptors
   (c) Hydrogen Donators
3. Natural and synthetic mucelages, thickeners, and gelatinous materials
4. Synthetic sweeteners
5. Synthetic flavoring agents
6. Surfactants (detergents, foaming agents)
7. Humectants
8. Preservatives and chemical sterilizing agents
9. Water conditioners (iodine, fluorides)
10. Antifoaming agents
11. Salt substitutes
12. Shortenings
13. Antistaling agents and softeners
14. Bleaches
15. Food modifiers and improvers (meat tenderizers, etc.)
16. Oil and fat substitutes of petroleum derivation
17. Organic solvents used as vehicles of some additives
18. Hydrogenated oils and fats (containing saturated, instead of the biologically important unsaturated, fatty acids and possibly nickel as a contaminant)
19. Hygroscopic and antihygroscopic agents
20. Emulsifiers and solidifiers

B. *Food Contaminants*

1. Pesticide residues
   (a) Bactericides
   (b) Insecticides—miticides
   (c) Rodenticides
   (d) Molluscicides
   (e) Fungicides
   (f) Herbicides
   (g) Nematocides
   (h) Defoliants

2. Antisprouting and antimaturation agents of fruits and vegetables
3. Insect repellents
4. Hormonal fattening agents—estrogens
5. Antibiotics (fed to food animals and added to foodstuffs)
6. Antienzymatics
7. Enzymes
8. Pan glazes (silicones)
9. Pan greases (mineral oils)
10. Water pollutants: coal tars and oils, petroleum tars, asphalts, oils, refinery and coke-oven effluents, chromates, radioactive substances, arsenicals, etc.
11. Chemical sterilizing agents
12. Wrapping and coating materials (paraffin, waxes, resins, plastics)
13. Soot adherent to smoked foodstuffs and roasted and toasted products
14. Household detergents and their coloring agents (stilbene derivatives)
15. Non-ionizing radiation (ultraviolet) products
16. Ionizing radiation (radioactive) products
17. Radioactive substances taken up by plants and food animals from contaminated soil or water or adhering to them in the form of radioactive fall-out.

Medical Evaluation

The medical evaluation of the effects of the food additives may be divided into several categories:

1. Acute disease—those diseases resulting from acute toxicity as a result of exposure to the offending agent.
2. Allergic reactions—these can be further divided into acute and chronic; but both can, on occasions, be fatal.
3. Third major category of diseases are those which are ordinarily referred to as chronic, and may be sub-divided into several groups. Further discussion of the effects leads to a detailed medical survey of the possible results of food additives, contaminants, and chemicals.

1. *Dermatologic or skin reactions.*

Pruritus—A sensation, generalized or localized, which the individual instinctively attempts to relieve by scratching the affected area. Itching may be produced by mildly irritant stimuli

acting on the epidermal nerve endings for pain. The peripheral and central thresholds for itching may vary considerably among individuals and, or in the same individuals. Secondary pruritus occurs in most skin diseases.

Erythemia Simplex—Redness of the skin, diffuse over wide areas or restricted to circumscribed patches due to hyperemia. Etiology may be drug sensitivity. Pruritus and burning alone or in combination may be present.

Hyperhidiosis (*Eudorrhea or Bromhidiosis*) is a condition in which the sweat glands are overactive. The resultant excessive perspiration may be general or confined to areas such as palms, soles, axillae, or groins. The skin appears often as erythematous or bluish-white areas. In severe cases maceration, fissuring or scaling of the skin occurs. Etiology often is a food allergy or contact dermatitis.

Acne Vulgaris—A common chronic inflammatory disease of the sebaceous glands and pilo sebaceous follicles of the skin characterized by comedosis, papules, pustules, cysts, inflammatory cysts or placques or nodules with or without scarring. Exciting causes may come of dietary excess of certain carbohydrates or fat, or allergy to certain foods. Ingestion of bromides or oxides may aggravate existing acne or may be the sole exciting factor (Halogen Acne). Contact with tar, paraffin, and chlorinated hydrocarbons may cause an Acne Artificialis.

Acne Rosacea—A chronic disease of the skin involving the flush areas of the face (nose, cheeks, chin) occurring in either sex, characterized by varying degrees of erythema, telangiectasis, comidones, erythematous papules, and in a few cases terminating in marked hypertrophy of tissue, especially the nose. Acne Rosacea is a disease of multiple etiological components, chief among which are neurovascular instability, gastro-intestinal disturbances, food idiosyncrasies, external irritants and others.

Pyoderma—Those acute inflammatory skin diseases which are caused by pyogenic bacteria usually staphlocaccus aureus or streptococcus hemolyticus. Various pyoderma differ only in severity and in the skin structures. Among the predisposing factors one should be on the alert for contact dermatitis.

Herpes Simplex—Otherwise described as fever blisters or cold sores. Herpetic keratosis is an acute virus infection characterized by the formation of groups of vesicles, individual or multiple, filled with clear fluid on raised inflammatory bases.

Primary infection may be accompanied by constitutional symptoms. Trigger mechanisms may produce repeated outbreaks, among which are food and drug allergies and contact dermitis.

Atopic Dermatitis—otherwise known as disseminated neuro dermatitis is a chronic superficial inflammation of skin characterized by thickening, excoration and lichenification with associated pruritus. Among the etiological causes are found allergens which precipitate the dermatitis (e. g. chocolate, oranges, strawberries, tomatoes, and contactants (e. g., wool, cotton, paint, cosmetics, oils). Inhalants (e. g., plants, pollen, dust) may be a factor.

Eczematoid Dermatitis—An acute, subacute or chronic skin disease, characterized by erythema, papules, and vesicles with varying degrees of infiltration, oozing, crusty, scaling and lichenification. Exciting factors which alone or in combination may precipitate the eruption include the followng: Contact with irritating and sensitizing agents such as strong acids or alkalies, mercury, sulfur, formalin, alcohol, streptomycin, cosmetics, medicaments used locally, and cleansing agents.

Contact Dermatitis—(Dermatitis Venenata) is an acute or chronic superficial inflammation of the skin caused by contact with sensitizing or irritating agents including vegetable, animal or mineral substances. Considered from an etiological standpoint there normally exists a balance between the resistance of the skins and the contactants to which it is exposed. The balance can be upset by excessive exposure to an allergen or by predisposing factors which decrease skin resistance such as trauma, excessive sweating with maceration, prolonged exposure to water and soap, age, and complexion (light more susceptible than dark).

Causative factors may be encountered in the environment: (1) Plants. (2) Trees. (3) Fruits and vegetables. (4) Chemicals —including p-phenylendiamine, mercury, chromic acid, pyrethrum, p-dichlorobenzene, D. D. T. (5) Therapeutic agents externally applied or encountered. Persons who handle such products in the course of their manufacture, sale, or administration may develop contact dermatitis from occasional or constant exposure. Such preparations often contain arsenic, mercury, iodine salicylic acid, quinine, penicillin. (6) Cosmetics, hair dyes, bleaches, tonics, deodorants, dipilatones, nail polishes, face creams, powders. (7) Clothing materials. (8) Miscellaneous substances such as soaps, lacquers, metals (gold, silver, nickel) vegetable gums, polishes, waxes and detergents.

2. *Carcinoma*

Of the chronic effects most feared, that of the ability to produce malignant tumors undoubtedly ranks highest. Very little is known about the relation of the vast majority of human cancers to specific chemical carcinogens. A new group of carcinogens are being introduced into our scientific literature. These are substances that alone are unable to produce tumors, but which will increase the ability of known carcinogens to exert their action. Species differ very much in their sensitivity to chemicals regarded as undoubted carcinogens. In other instances, the route of administration or contact may determine whether or not the chemical carcinogen will give rise to a tumor. Substances carcinogenic to animals are all toxic in the large doses. Specific tests for carcinogenic activity should eventually be developed; however, at the present time, there is no agreement on what constitutes a satisfactory series of animal tests. At the present time in the Food & Drug Administration laboratories, tests for carcinogenity of a compound known as F. D. & C. Yellow No. 6 is being attempted on rats and dogs. In conclusion, these tests will probably only tell us whether or not the chemical is able to produce tumors in that particular animal. It cannot be assumed that a chemical producing tumor in one species will be carcinogenic in other species such as man.

3. *Acute Hemolytic Anemias (Toxic or acquired)*

Among the toxic agents many chemical agents will cause hemolysis of blood in most individuals exposed to a sufficient high concentration of the substance. Among these are phenyl hydrazine, benzene, toluene, para-amino-phenol, nitrophenal, nitrites, potassium chlorate, methyl chloride, seponim, colloidal silver, lead and arsenic.

Anemia due to bone marrow failure—Aplastic anemia associated with leukopenia and thrombocytopenia as a result of toxic depression of blood formation. These may include chemical agents such as benzene, dinitrophenol, trinitrotoluene, gold, arsenic, quinacrine, chloromphemical, radio active phosphorus and radium.

Agranulocytosis—Characterized by an acute illness due to chemical or drug hypersensitivity, and characterized by fever and extreme weakness, manifested by diminution in the number of granulocytes in the bloodstream. Chemicals producing this may include organic arsenicals, gold salts and benzene.

4. *Gastro-Intestinal Disorders*

Stomatitis—an inflammatory condition of the mouth which may occur as a primary disease or a symptom of a systemic disease. Stomatitis may result from the excessive use of irritants such as alcohol, tobacco or from sensitization to substances or chemical additives in toothpaste, mouth washes, candy dyes, and the plastic in dentures. Oral leukoplakia of mucous membranes of the mouth may result in long standing chronic chemical irritations.

Gastro-Enteritis—manifested by a symptom complex, including nausea, heartburn, abdominal pain, flatulence, and eructation. Indigestion may be caused by organic disease, but chemical irritation and allergic manifestations from chemical additives to foods have been predisposing factors.

Gastritis—Inflammation of the mucous membranes of the stomach may be caused by acute indigestion of (1) some chemicals as alcohol, creosote, coal-tar products, iodides, bromides; (2) acute corrosive gastritis following irritation by strong acids or caustics, iodine, potassium, salts of arsenic, mercury, zinc or lead. The symptoms of acute exogenous gastritis may be manifest from 6 to 24 hours after ingestion of the offending agent. They are symptoms of malaise, anorexia, epigastric pressure, nausea, headache, vertigo, vomiting, prostration and exhaustion. Symptoms may progress after 24-48 hours to collapse with bradycardia, severe epigastric pain, hematemesis and rigidity of the abdomen.

Botulism—An acute intoxication manifested by neuromuscular disturbances following the ingestion of food containing toxins elaborated by Clostridium botulinum.

Metal Contaminants—Particularly bismuth compounds, cadmium, arsenic, cobalt and lead. Ingestion of sufficient quantities may produce a sweetish metallic taste, great thirst, nausea, vomiting, abdominal pain, headache, fever, stomatitis, and in long standing contamination and ingestion a bluish discoloration of the gums with dermatitis.

5. *Acute Hepatitis*—is an inflammation of the liver caused by infections or toxic agents characterized by jaundice and enlargement of the liver, usually accompanied by fever and other systemic disorders. Toxic agents may be chemicals which include carbon tetrachloride, arsenicals and tetrachlorethene.

Toxic Hepatitis—caused by a wide variety of chemicals taken into the system by inhalation, ingestion, skin absorption or in-

jection. In some instances the liver injury is directly related to the degree of exposure; in others sensitivity to the agent. Histopathologic changes in the liver consist of fatty necrosis and fatty infiltration. Chronic poisoning with certain chemicals, such as carbon tetrachloride and phosphorus, leads to cirrhosis.

6. *Neuritis and Neuralgias*—are diseases usually degenerative but may be accompanied by signs of inflammation of a single nerve or two or more nerves in separate areas or many nerves simultaneously (polyneuritis). In addition to mechanical, vascular, infectious, metabolic there is a large group whose etiology can be traced to toxic substances. These substances causing a polyneuritis may be poisons by heavy metals (lead, arsenic, gold, thallium, mercury, bismuth, copper, antimony, zinc, tin, silver, manganese). Hydro-carbons and organic solvents figure heavily among non-metallic toxins, which include alcohol, carbon monoxide, carbon disulfide, carbon tetrachloride, tetra chlorethene, benzene and chlorobutanol. In Polyneuritis, the sensory symptoms predominate. Tingling, pins and needles, burning, boring, and stabbing are some of the descriptive adjectives patients use. Pain often is worse at night. Numbness and objective loss of sensation occur in severe cases. Symptoms of weakness may progress to complete paralysis. Deformities of extremities may occur, especially in untreated cases. Cerebral symptoms of confusion, delirium and headaches occur with central nervous system involvement.

Specific Poisons or Toxicology

Aniline dyes and inks—Symptoms and signs depend upon the quantity of the chemical and the length of time of exposure. Symptoms and signs of aniline poisoning include cyanosis due to formation of methmoglobin and sulfhemoglobin; dyspnoea, weakness, vertigo; weak and irregular pulse; anginal pains, rashes or urticaria; occasional vomiting, delirium followed by depression; death from circulatory or respiratory failure.

ACIDS and ALKALIES

Acetic	Ammonia water
Hydrochloric	Potash (Potassium Hydroxide)
Nitric	Lye (Sodium Hydroxide)
Nitrohydrochloric	Carbonates of sodium or potassium
Phosphoric	
Sulphuric	

The symptoms and signs include: corrosion of the mucous membranes of the mouth, throat and esophagus; pain in the digestive tract, intense thirst, dypsphagia; nausea and vomiting, diarrhea, collapse with feeble pulse, difficult breathing. Later effects are inflammation with ulcerations of mouth, throat, esophagus, mediastinitis, gastritis, enteritis, jaundice, albuminoria, perforation or strictures.

Chromic Acid—signs are mainly gastrointestinal, leg cramps, yellow stained throat and possible collapse. Benzene, which includes naphtha and petroleum ether, produces symptoms of gastritis, burning in the mouth, inebriation, tremors, convulsions and coma.

D. D. T. or chlorinated organic insecticides

Aldrin	Methoxychlor
Benzene hexachloride	T. E. E.
D. D. D.	Toxaphene

Symptoms and signs include giddiness, nausea, vomiting, numbness, and tremors of the muscles of the head, neck and later of extremities; convulsions followed by depression, coma, and death in respiratory failure and possible ventricular fibrillation. Non-fatal cases may show degeneration of the liver and central nervous system.

Tin salts—Symptoms produced are a metallic taste, gastric enteritis, colic, vomiting, diarrhea, general weakness, diminished heart action, motor paralysis leading to atoxia, stiffness, irregular movements and occasionally convulsions.

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