

**II Seminário de Corantes Naturais para Alimentos
I Simpósio Internacional de Urucum**

APPLICATION OF ANNATTO COLORS

Mikio NAKAMURA

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SAN-EI Chemical Industries, Ltd.

1. INTRODUCTION

1.1 History of Annatto Application

The history of annatto begins with its application as an external coloring for Vienna sausage. Vienna sausage was first introduced in the 1940's and was regarded as a "red" food. In the beginning, the colors used to dye Vienna sausages were Edible Color N^o 102 as an internal color, and Edible Orange Color N^o 1 as an external color. Afterwards it was found that one of annatto colors' features is its total non-migration of color into the internal section of meat. This non-bleeding property is due to annatto's high dyeing property to the meat protein. Hence annatto was considered preferable to color Vienna sausages. Accordingly, gradually annatto colors came to be used as an external coloring for Vienna sausages. However in 1966 Edible Orange Color N^o 1 was deleted from the Edible Color List; the market needed a substitute urgently, resulting in rapid increase in the use of annatto colors.

Annatto colors were introduced into Japan around 1963 and widely used as natural colors in processed foods.

1.2 Activities of SAN-EI Chemical Industries, Ltd.

As one of main annatto color suppliers, SAN-EI Chemical Industries Ltd. (hereinafter referred to as SAN-EI) plays an important role in meeting the domestic market needs. Along with introducing annatto colors into Japan, SAN-EI began producing annatto colors in various physical forms, including oil solutions, suspensions and powders. In order to ensure constant supply of annatto to the expanding market, SAN-EI supplied the Kenyan government with the technical knowledge for production of annatto colors, and started producing annatto in Kenya in 1980. Furthermore, SAN-EI built a cooperative enterprise in Peru, and started importing annatto colors from Peru in 1988. These activities have greatly enriched the Japanese market with annatto colors, and have also maintained the stability of the annatto color supply. It is said that the history of SAN-EI is the history of Food Color production in Japan; annatto color production is by all means no exception.

2. LEGISLATION OF ANNATTO COLORS

2.1 History of Legislation in Japan

The Food Sanitary Act was initially enforced in 1947. The Ministry of Health and Welfare issued the Food Additive Codex (1st edition) in 1960, but did not include annatto colors because annatto colors were not introduced in Japan. Until 1943 water-soluble annatto was first included in the Japanese Standard of Food Additive (3rd edition) issued by the Ministry of Health and Welfare in 1974. In 1976, the Japan Food Additive Association worked out the Voluntary standard of Natural Food additives, wherein dispersible annatto colors were included.

2.2 Features of Food Sanitation Law in Japan

There are two systems for Food Sanitation Law: (1) the Designation System, and (2) the Notification System. The Designation System is adopted for synthetic chemical additives, and the Japanese Standards of Food Additives, covering 347 items, describes their specifications. The Notification System governs over the food Additives other than the synthetic chemicals. About 1,000 items are listed in the Notification System, but no specifications are stipulated. Dispersible and oil-soluble annatto are extracted from annatto seeds, and are not considered synthetic chemical colors.

2.3 Labeling

In November 1989, a law was officially announced for the non-distinction of synthetic chemical additives from other food additives in food labeling. This law required the labeling of all and every food additives in processed foods. Table 1 shows an example which describes the labeling of annatto colors in processed food according to the new law.

Enforcement of this law begins on June 30, 1991.

Table 1: Labeling of annatto colors in processed food.

Product name	Composition	Labeling of food
ANNATTO COLOR A (synthetic color)	water-soluble Annatto as norbixin: 4%	Annatto color
ANNATTO COLOR B (annatto extract)	annatto color as norbixin: 4%	Annatto color

3. MARKET OF ANNATTO

3.1 Market Size

The processed food industry boasts of sales amounting to 20,000 billion yen. The food additive industry, however, totals 400 billion yen, not large enough to form an independent industry. In Japan even the Pachinko (pinball game) industry is ten times larger than the food additive industry, amounting to 4,000 billion yen. Concerning colors, the synthetic color industry totals 1.5 billion yen, and the natural color industry totals 20 billion yen of which annatto colors account for 800 million.

3.2 Features of Japanese Market

Since very long ago, Japanese food were very colorful. However they are not vivid in color, but have soft color tones to give natural appearance. The same applies to processed food. Soft natural color tones are preferred and favored. To consumers, buying food is similar to buying TVs, automobiles, etc., where high quality is expected and required. These high quality standards create excessive specifications for food colors. Annatto colors are no exception. People are extremely cautious about the safety of food additives.

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The Japanese market of foods colors is closely influenced by the world market, especially by the U.S.A. color market. For example, the US and Japan concurred about the safety of FD&C Red N^o 3, The U.S. and Japan's relationship is so close that it is said "Japan would catch cold, if the U.S. sneezes". Another characteristic of annatto colors in Japanese market is that it is a matured market; no large expansion can be expected. However fierce competition is considered to intensify in terms of quality and price in the future.

4. ANNATTO COLORS

4.1 Raw material of annatto colors

The annatto tree (*Bixa orellana*) is a large, fast-growing shrub cultivated in tropical climates, including parts of South America, India, East Africa, and the Caribbean. The tree produces large clusters of brown, or crimson, capsular fruit containing seeds coated with a thin, highly colored, resinous coating. The seeds serve as the raw material for the preparation of the colorant known as annatto extract.

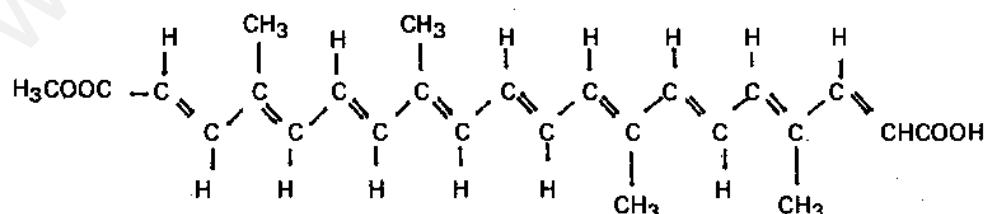
4.2 Annatto Extract

The colorant is prepared by leaching the annatto seeds with an extractant prepared from one or more approved, food-grade materials taken from a list that includes various solvents, edible vegetable oils and fats, and alkaline aqueous and alcoholic solutions. Depending on the use intended, the alkaline extracts are often treated with food-grade acids to precipitate the annatto pigments, which in turn may or may not be further purified by recrystallization from an approved solvent.

4.2.1 Properties of Oil or Fat Extract

The chief coloring principal found in the oil or fat extracts of annatto seeds is the carotenoid bixin. The chemical constitution of bixin was identified by R. Kuhn etc. and P. Karrer etc. in 1953.

■ BIXIN



BIXIN: C₂₅H₃₀O₄ (mw 394.51)

Chemical Constitution of Bixin

Bixin possesses two stereochemical configurations, i.e. cis- and trans- configuration. Most of bixin obtained from annatto seeds is in the cis-configuration, however the cis-isomer of bixin is labile under normal condition, and transfer to the trans-isomer.

The important physical properties of bixin is a follows:

Melting point: 198°C

Maximum absorbance in chloroform: 503nm, 469.5nm, 439nm

Maximum absorbance in carbon disulfide: 526nm, 491nm, 457nm

Soluble in: acetone, chloroform, alkaline aqueous solution.

Insoluble in: water

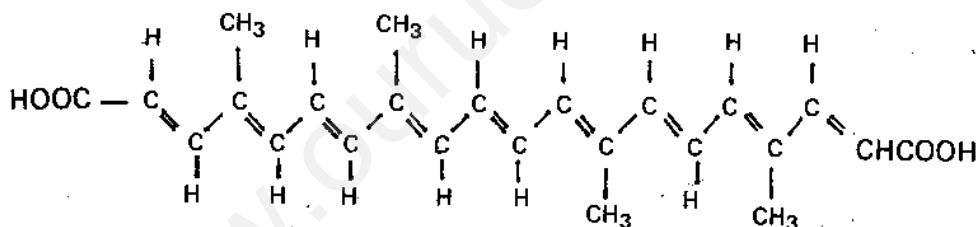
Slightly soluble in: ethyl alcohol, propylene glycol etc.

Unconcentrated bixin extract is a yellow liquid, concentrated bixin extract appears dark red in color and moderate bixin extract has greenish yellow hue. The extract has good stability toward oxidation, pH change and microbiological attack, and is moderately stable toward light. Bixin is very stable toward heat up to 100°C, fairly stable at 100-125°C and unstable above 125°C.

4.2.2 Properties of alkaline aqueous extract

The major colorant in alkaline aqueous extracts is norbixin which is produced by pressured hydrolyzation of bixin during extraction. The constitution of norbixin is as follows:

■ NORBIXIN



NORBIXIN: $C_{24}H_{28}O_4$ (mw 380.48)

Chemical Constitution of Norbixin

Norbixin possesses the following important properties:

Melting point: above 300°C

Maximum absorbance in carbon disulfide: 527nm, 491nm, 458nm

Soluble in: glacial acetic acid

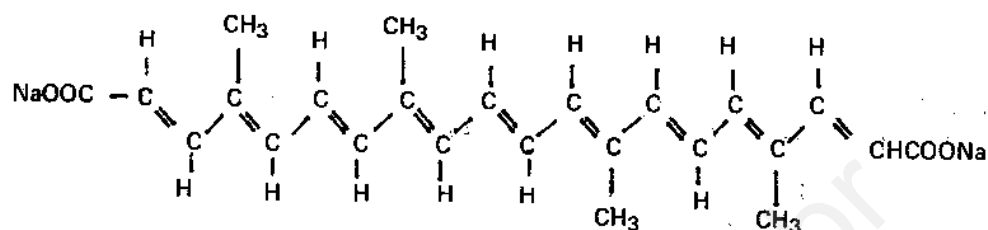
Insoluble in: water, alcohol, propylene glycol, oil and fat

The stabilities toward light, heat and pH change are slightly better than bixin.

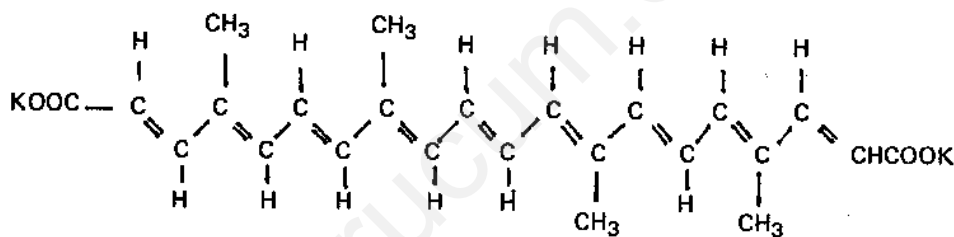
4.2.3 Properties of Water-soluble Annatto

When annatto seeds are extracted by NaOH or KOH solution under 70°C, water-soluble annatto extract can be obtained. The principal pigment of water-soluble annatto extract is sodium norbixin or potassium norbixin.

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Chemical Constitution of Sodium Norbixin



Chemical Constitution of Potassium Norbixin

Water-soluble annatto was designated as a synthetic chemical food additive in 1967 because it is a compound of norbixin and an alkali.

Sodium or potassium norbixin dissolves in water easily, is insoluble in acetone, chloroform, ester and oil/fat and slightly soluble in alcohol. The maximum absorbances in 0.01% NaOH solution are 454nm and 482nm.

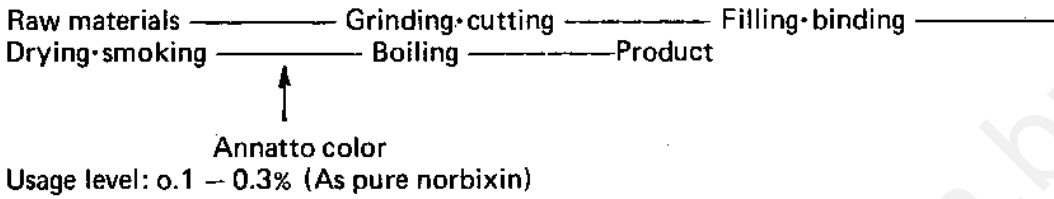
5. APPLICATION OF ANNATTO COLORS

As shown above, annatto colors appear in three categories: (1) oil-soluble colors which contain bixin as the main colorant; (2) water-dispersible colors of which the main colorant is norbixin, and; (3) water-soluble colors containing sodium or potassium norbixin as the main colorant. Oil-soluble colors are generally used to color oil and fatty foods such as margarine, chocolate, butter. Water-dispersible colors are suitable for processed foods such as nougat, miso, sauce for roast meat, instant pudding, Korean pickles, etc. Water-soluble colors, characterized by a strong dye binding to protein and a high solubility in water, are suitable for Vienna sausage, Octopus surface coloring, chewing gum, sherbet, etc. However due to the transformation of sodium or potassium norbixin to nobixin in acidic solutions, water-soluble colors are not suitable for acidic foods. The emulsification of annatto colors make their applications wider and more complicated. The application of annatto colors to typical processing foods is shown in the following simple diagrams.

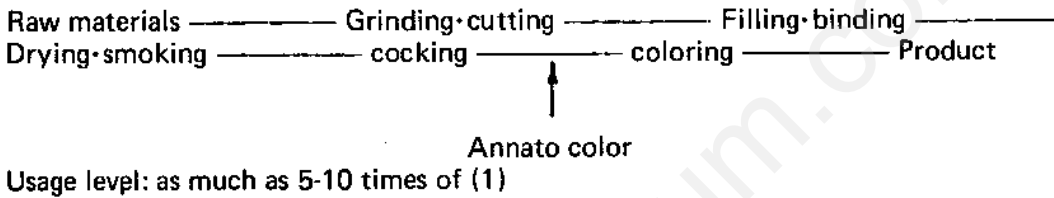
5.1 Vienna sausage

Two coloring methods are often applied.

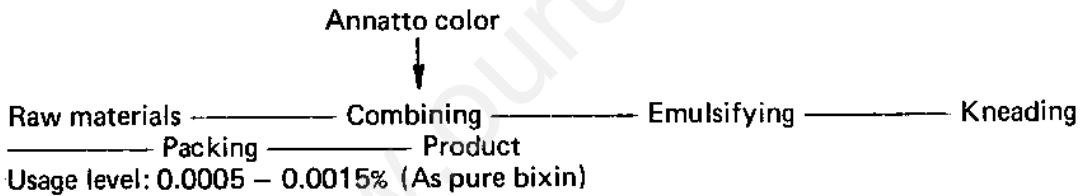
(1) Boil coloring



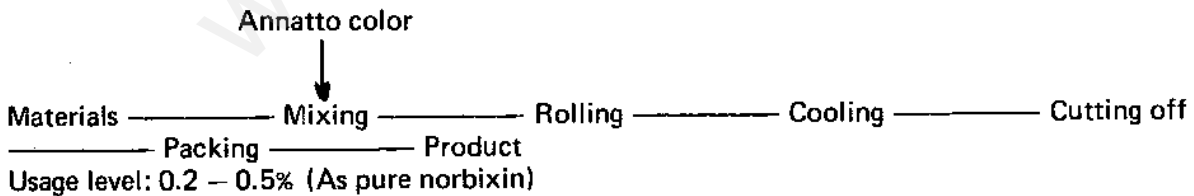
(2) Instantaneous coloring



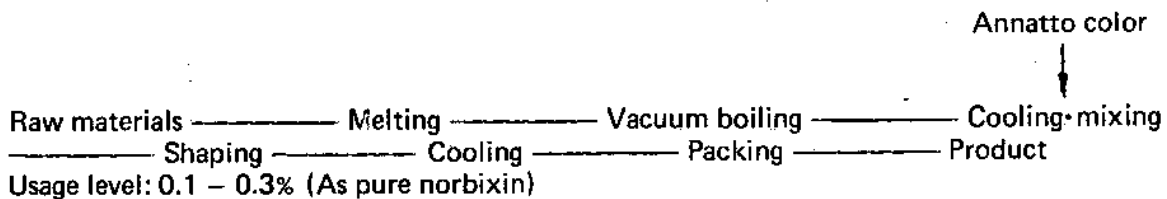
5.2 Margarin



5.3 Chewing Gum

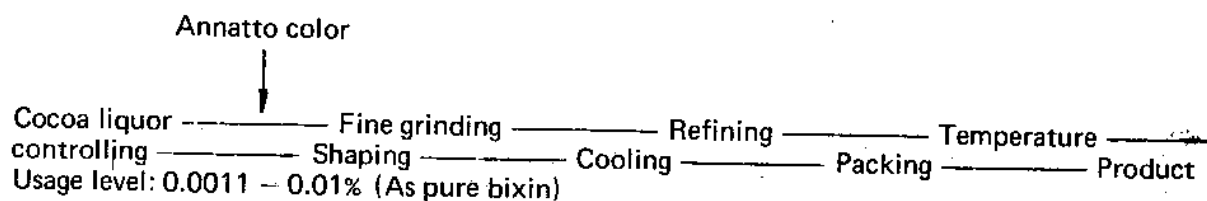


5.4 Candy

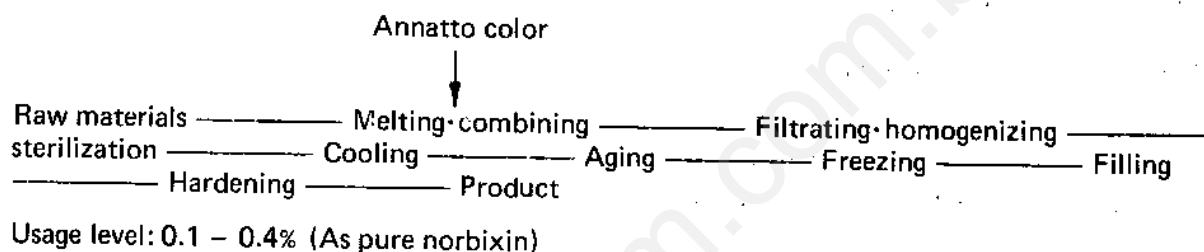


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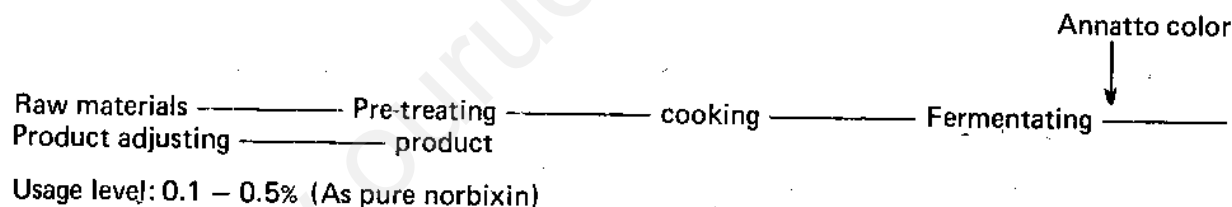
5.5 Chocolate



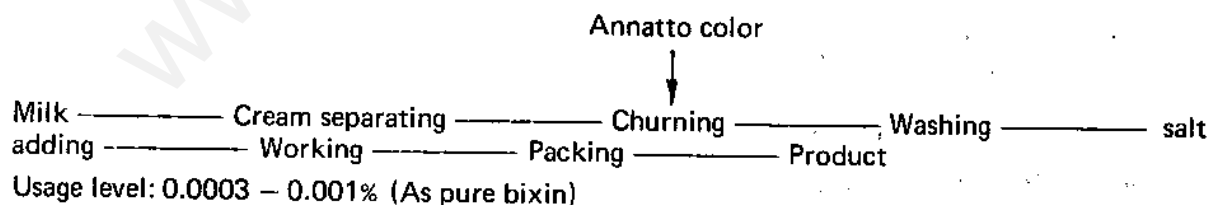
5.6 Ice cream



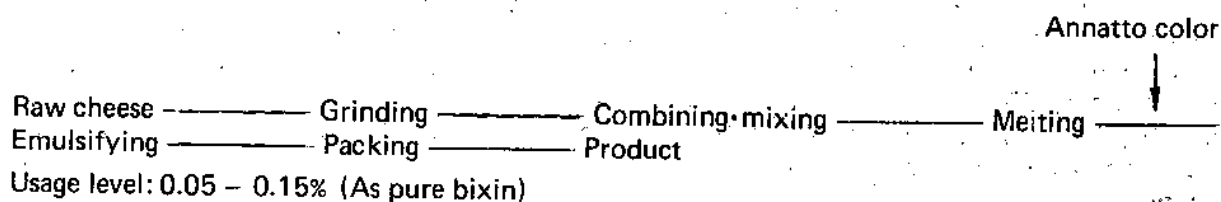
5.7 Miso



5.8 Butter

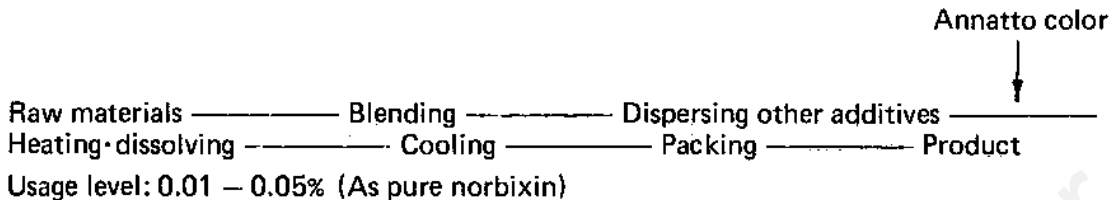


5.9 Cheese

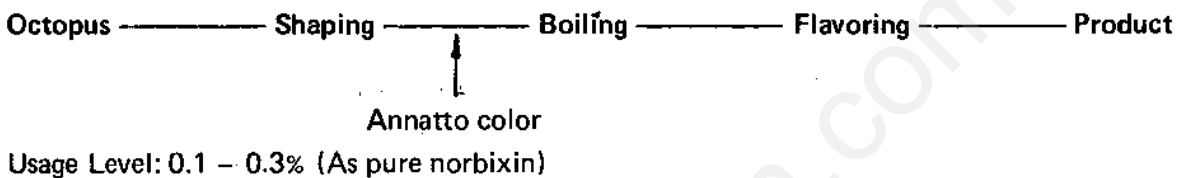


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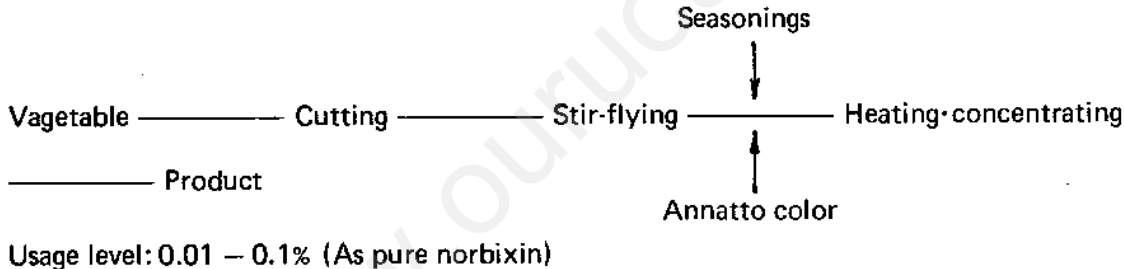
5.10 Pudding



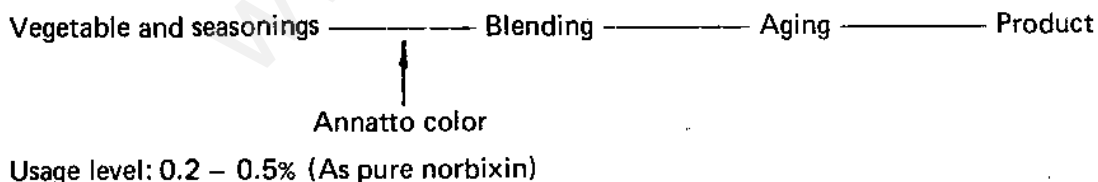
5.11 Octopus surface coloring



5.12 Sauce for roast meat



5.13 Korean pickles



6. SUMMARY

Annatto colors are comparatively inexpensive colors among the natural colors. Three kinds of colors, i.e. oil-soluble, water-dispersible and water-soluble colors, make annatto colors applicable to various processed foods. Furthermore, many large annatto cultivation guarantee its stable supply. These characteristics make annatto a very attractive color source, as weak light stability is a drawback of annatto colors. As the Japanese market of annatto colors matures, competitions in the quality and price of annatto colors will be important issues for natural color supplies.