BRIDGIOUS SERIES 0752676417

ITEM 1:

A small food processing company has been working on producing a nutrient-fortified vegetable juice as part of a school feeding program. The company added a fortificant to improve the nutritional content, claiming it would enhance the mineral value of the juice. However, not long after bottling, the juice began to turn **brown**, even when properly stored. This browning is a known indicator of spoilage and has raised safety concerns.

The production team was informed that the browning may be due to a chemical additive (salt) that was used as the fortificant. Your school has obtained a **sample** of this additive**,** labelled **Sample F**, and you have been tasked with identifying the cation and anion it contains.

Task:

a) Design and carry out a scientific investigation to determine, the **cation** and **anion** present in Sample F (the suspected additive) and explain how these ions could cause or contribute to the browning of vegetable juice**.**

Aim:

An experiment to investigate the cation and anion in food additive that was added in food product so as to explain what caused the browning.

Hypothesis:

The browning of the food product was due to the cation present in the food additive.

Variables:

Independent variable: Nature of sample F. Testing reagent used.

Dependent variable: Colour of the flame, colour change, precipitation

Fixed variable: Amount of testing reagent used, Amount of sample F used.

Risks and mitigation:

Inhalation of volatile solvent causing respiratory irritation, dizziness **Mitigation** conduct analysis with masks on. Skin irritation due to spillage that exposes the chemical to skin **Mitigation** wear gloves and goggles, handle reagents carefully.

TESTS	**OBSERVATION**	**DEDUCTION**
(a) Two spatula-end full of solid F were placed in a dry test tube and heated strongly over a Bunsen burner flame until no further change was observed.	A green crystalline solid Colourless was formed condensate on the cooler parts of the test tube and this turned turns anhydrous copper(II) sulphate from white to blue. A brown residue was formed	Fe^{2+} Hydrated salt Fe^{2+} converted to Fe^{3+}
(b) One spatula-end full of solid F was placed in a test tube. 2 drops of concentrated sulphuric acid were added, and the mixture was warmed over a low Bunsen flame.	A colourless gas that forms dense white fumes with concentrated NH_3 was give off	HCl produced Cl- present
(d) 10.0 cm^3 of distilled water was measured using a measuring cylinder and transferred into a test tube. Two spatula end-fuls of solid F were added and solution mixed. thoroughly until all the solid had dissolved, and the resulting solution was then divided equally into six separate portions for further tests.	A green solution was formed.	Cu^{2+}, Fe^{2+}, Ni^{2+}
(i) To the first portion of the solution of F, dilute sodium hydroxide solution was added dropwise using a dropper while observing any change. The addition was	A green precipitate insoluble in excess was formed and turned brown on standing	Fe^{2+}

continued until the reagent was in excess.		
(ii) To the second portion of the solution of F, dilute ammonia solution was added dropwise using a dropper while observing any changes. The addition was continued until the reagent was in excess.	A green precipitate insoluble in excess was formed and turned brown on standing	Fe^{2+}
(iii) To the third portion of the solution of F, 2 drops of potassium hexacyanoferrate(III) solution were added using a dropper, and any changes.	A dark blue precipitate was fromed.	Fe^{2+}
(iv) To the fourth portion of the solution of F, 3 drops of lead(II) nitrate solution were added using a dropper**,** followed by a few drops of dilute nitric acid with another cleaner dropper.	A white precipitate insoluble in acid formed.	Cl- or SO_4^{2-}
(v) To the fourth portion of the solution of F, 3 drops of Barium nitrate nitrate solution were added using a dropper**,** followed by a few drops of dilute nitric acid with another cleaner dropper.	A white precipitate insoluble in acid formed.	SO_4^{2-} absent

b) Conclusion and recommendation

Cation : Fe^{2+} and Anion SO_4^{2-}

Fe^{2+} ions are oxidized to Fe^{3+} ions and Oygen (O_2) is reduced. Hydroxide ions (OH^-) are formed, and this can lead to the formation of brown $Fe(OH)_3$ precipitate, which causes browning in food products.

$$4Fe^{2+}_{(aq)} + O_{2(g)} + 6H_2O_{(l)} \longrightarrow 4Fe^{3+}_{(aq)} + 4^-OH_{(aq)}$$

Recommendation: Store juice under low oxygen conditions or include antioxidants to slow Fe^{2+} oxidation.