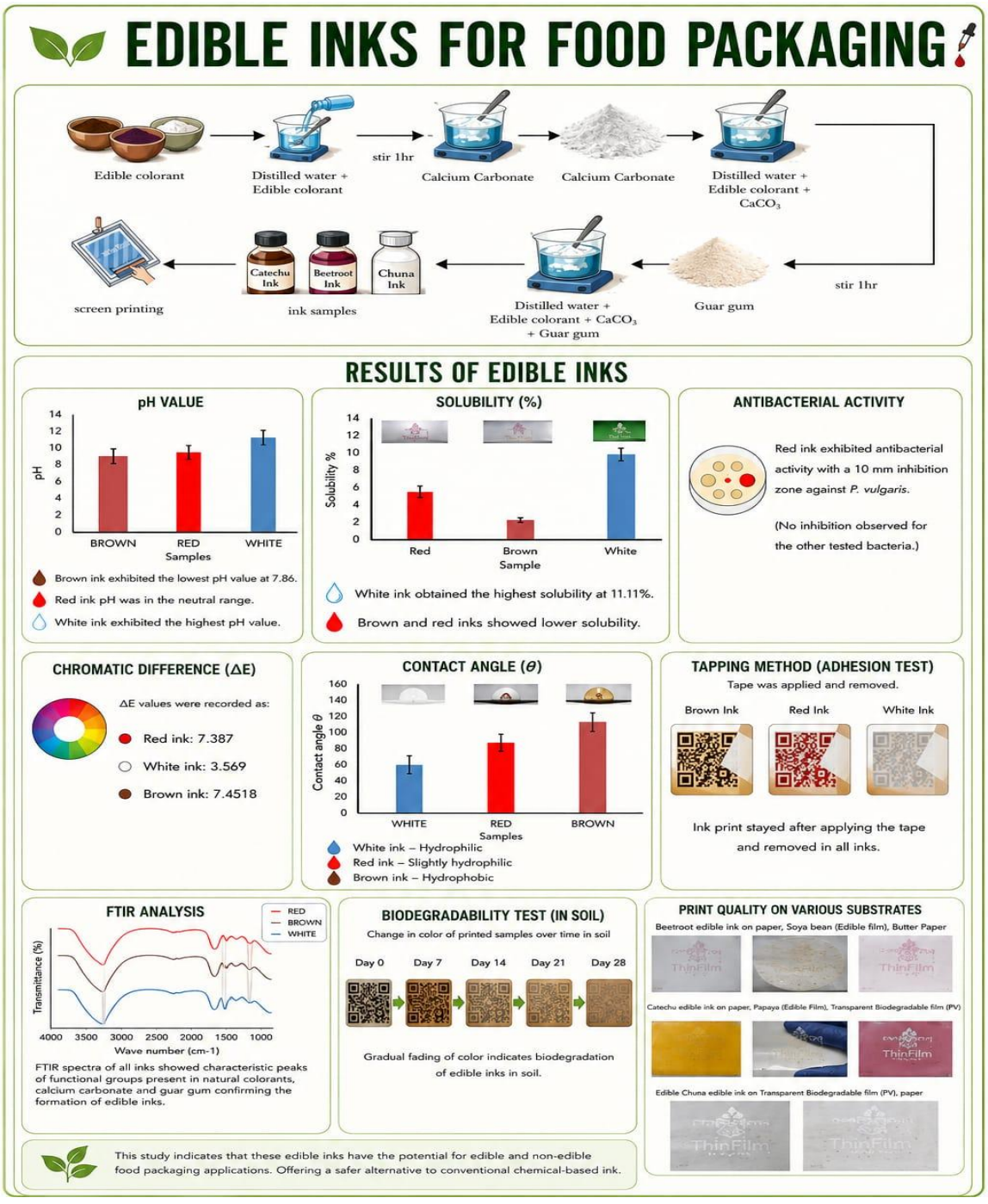
Master's Thesis Information Showcase
Spring Semester-2026
Year 2026

	Department: Physics Programme: Master's in Science Specialization: Physics
1	**Title of the Thesis** Development of Edible Inks for Food Packaging
2	**Abstract** (min 300 to 500 words) Edible ink usage is one of the crucial recent trends in food printing, safe and aesthetic, high-quality printing. This study on edible ink reviews current research and develops new edible inks with colors and economical raw materials. To identify edible ink composition, applications, and challenges, both for manufacturers and consumers. Edible ink ingredients are safe and food-grade. Edible inks are used on cakes and candy, and there is a lot of stuff that can be used in our daily lives. The use of edible inks for QR codes, decoration, branding, and custom designs. However, the use of edible inks remains limited due to a limited color selection, print quality, and precision. Nevertheless, the advantages of edible ink make it a valuable asset to today's food processing and manufacturing industries. Future improvements to edible ink are needed to enhance its performance and broaden its applications. In this study, the three pigmented edible inks: Catechu (brown ink), Beetroot (red ink), and Edible Chuna (white ink) were formulated. Calcium carbonate, as a functional agent, was used in 0.5 - 0.75w%, and guar gum, as a binder, was present in 0.2 - 0.4w%. The prepared ink was evaluated for its pH value, chromatic properties, biodegradability, solubility, and contact angle. All edible inks exhibited excellent print quality across various packaging substrates, including paper, butter paper, edible films (papaya & soybean), bridgeable PV-based film, an apple, mango, bread, and a biscuit. Brown ink exhibited the lowest pH value, at 7.86. White ink obtained the highest solubility at 11.11%. Red ink exhibited antibacterial activity, with a 10 mm inhibition zone against P. vulgaris. Chromatic differences (ΔE) were recorded from red ink (7.387), white ink (3.569), and brown ink (7.4518). Contact angle measurements revealed hydrophilic behavior for white inks, slightly hydrophilic behavior for red ink, and hydrophobic behavior for brown ink. This study indicates that these edible inks have the potential for edible and non-edible food packaging applications. Offering a safer alternative to conventional chemical-based ink.
3	**Impact on SDG#___"** (min 500 words) The development and use of edible inks support several Sustainable Development Goals (SDGs) by promoting safer and more sustainable food packaging solutions. It aids **SDG 2:** Zero Hunger by allowing safe labeling directly on food products. This reduces contamination risks, improves food safety and traceability, and minimizes food waste from damaged or non-recyclable packaging. The innovation also helps.

	SDG 3: Good Health and Well-Being by replacing toxic, chemical-based inks with food-grade, non-toxic alternatives. This change reduces consumer exposure to harmful substances that may leach from packaging materials. Additionally, edible inks promote. **SDG 9:** Industry, Innovation, and Infrastructure by encouraging the development of bio-based and edible materials. They strengthen research and innovation in sustainable packaging technologies and support circular economy principles in the food industry. Moreover, edible inks contribute too. **SDG 13:** Climate Action by lowering environmental impacts. They reduce plastic waste and chemical pollution while using renewable, biodegradable ingredients that help cut down the overall carbon footprint of packaging systems.
4	**Scholar Name** (along with contact details) Areeba Hussain (Roll No: PH:245022) PG Student in Physics Email ID: areebahussain267@gmail.com
5	**Supervisor & Co-supervisor Name** (along with contact details) Dr. Iftikhar Ahmed Channa, Department of Metallurgical Engineering, NEDUET Email: iftikharc@neduet.edu.pk Dr. Saba Javaid, Department of Physics, NEDUET Email: sabaj@neduet.edu.pk Prof. Dr Ali Dad Chandio, Department of Metallurgical Engineering NEDUET Email: alidad@neduet.edu.pk
6	**Graphical Abstract**


EDIBLE INKS FOR FOOD PACKAGING
Edible colorant
Distilled water + Edible colorant
stir 1hr
Calcium Carbonate
Calcium Carbonate
Distilled water + Edible colorant + $CaCO_3$
stir 1hr
Guar gum
Distilled water + Edible colorant + $CaCO_3$ + Guar gum
Catechu Ink
Beetroot Ink
Chuna Ink
ink samples
screen printing
RESULTS OF EDIBLE INKS
pH VALUE
pH
BROWN
RED
WHITE
Samples
Brown ink exhibited the lowest pH value at 7.86.
Red ink pH was in the neutral range.
White ink exhibited the highest pH value.
SOLUBILITY (%)
Solubility %
Red
Brown
White
Sample
White ink obtained the highest solubility at 11.11%.
Brown and red inks showed lower solubility.
ANTIBACTERIAL ACTIVITY
Red ink exhibited antibacterial activity with a 10 mm inhibition zone against P. vulgaris.
(No inhibition observed for the other tested bacteria.)
CHROMATIC DIFFERENCE (ΔE)
ΔE values were recorded as:
Red ink: 7.387
White ink: 3.569
Brown ink: 7.4518
CONTACT ANGLE (θ)
Contact angle θ
WHITE
RED
BROWN
Samples
White ink – Hydrophilic
Red ink – Slightly hydrophilic
Brown ink – Hydrophobic
TAPPING METHOD (ADHESION TEST)
Tape was applied and removed.
Brown Ink
Red Ink
White Ink
Ink print stayed after applying the tape and removed in all inks.
FTIR ANALYSIS
RED
BROWN
WHITE
Transmittance (%)
Wave number (cm-1)
FTIR spectra of all inks showed characteristic peaks of functional groups present in natural colorants, calcium carbonate and guar gum confirming the formation of edible inks.
BIODEGRADABILITY TEST (IN SOIL)
Change in color of printed samples over time in soil
Day 0
Day 7
Day 14
Day 21
Day 28
Gradual fading of color indicates biodegradation of edible inks in soil.
PRINT QUALITY ON VARIOUS SUBSTRATES
Beetroot edible ink on paper, Soya bean (Edible film), Butter Paper
Catechu edible ink on paper, Papaya (Edible Film), Transparent Biodegradable film (PV)
Edible Chuna edible ink on Transparent Biodegradable film (PV), paper
This study indicates that these edible inks have the potential for edible and non-edible food packaging applications. Offering a safer alternative to conventional chemical-based ink.