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Comprehensive Characterization And Quality Control Of Ferric Derisomaltose Manufactured By WBCIL To Ensure Purity And Potency For High-Dose Intravenous Iron Therapy

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Abstract
Ferric Derisomaltose is an advanced intravenous iron complex crucial for treating iron deficiency anaemia. This article details the comprehensive specification and characterization of this compound manufactured by West Bengal Chemical Industries Ltd., Kolkata, India (WBCIL) based on rigorous analytical techniques. The methodology employed internal Standard Testing Procedures (STP) to confirm identity, measure potency, control impurities, and verify safety. Results confirmed the material's identity as a brown coloured free flowing powder with characteristic positive tests for both iron and carbohydrate and spectral conformation by IR. Quantitative assays demonstrated high potency, with Iron Content confirmed as NLT 25.0% and Carbohydrate content as NLT 24.0% (on a dried basis), both determined by established titrimetric and colorimetric methods, respectively. Crucially, impurity testing confirmed the absence of Free Ferric Ion and adherence to strict limits for heavy metals such as Arsenic (NMT 2.0 ppm) and Lead (NMT 10.0 ppm). Furthermore, the material met microbiological safety standards, including a critical Endotoxin limit of NMT 0.35 EU/mg as determined by the Gel-Clot technique. These findings collectively confirm that Ferric Derisomaltose manufactured by WBCIL meets all established quality, efficacy, and safety specifications required for a high-quality pharmaceutical active ingredient.

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I. Introduction

Ferric Derisomaltose is a critical therapeutic agent for patients who require rapid iron repletion. is exceptionally efficient at replenishing iron stores following accidental or acute blood loss due to its unique "total-dose infusion" capability.[1] Unlike traditional iron treatments that require multiple hospital visits, the stable molecular structure of Ferric Derisomaltose allows for the delivery of up to 2000 mg of iron in a single 15-to-30-minute session.[2] This rapid repletion is clinically critical in trauma or surgical scenarios where the body's iron reserves are suddenly exhausted, as it bypasses the slow and limited absorption of the digestive tract.[2] Research indicates that therapeutic responses, such as an increase in reticulocyte count (new red blood cell production), can be detected within just a few days of administration. By providing a swift "hike" in bioavailable iron, Ferric Derisomaltose significantly reduces the dependence on red blood cell transfusions, mitigates the risk of transfusion-related complications, and accelerates the restoration of haemoglobin levels to stabilize the patient's cardiovascular and metabolic health.[4] Ferric Derisomaltose represents a significant development in the therapeutic landscape for treating iron deficiency anemia (IDA), particularly in populations requiring rapid iron repletion or those who have failed or are intolerant to oral iron therapy.[1] As a stable, high-dose intravenous (IV) iron replacement product, Ferric Derisomaltose is structurally defined as an iron-carbohydrate complex, where ferric iron (Fe^{3+}) is tightly bound to a derisomaltose ligand.[2] The clinical importance of this specific complex lies in its ability to be safely administered in high single doses, up to 1000 mg, which facilitates swift and efficient iron delivery directly to the reticuloendothelial system (RES) for storage and subsequent release.[3] This capability is paramount for conditions like chronic kidney disease (CKD), where inflammation hinders the efficacy of oral iron, and for conditions requiring quick normalization of haemoglobin and iron stores.[4] The unique molecular structure ensures that the complex is stable in serum and is primarily internalized by macrophages, thereby guaranteeing a slow, controlled release of bioavailable iron to the transport protein transferrin.[5] This controlled clearance mechanism is the key to its excellent safety profile, as it effectively minimizes the formation of non-transferrin-bound iron and potentially toxic free ferric ions in the circulation, which are implicated in oxidative stress and severe hypersensitivity reactions associated with less stable iron complexes.[6] Given the critical nature of this therapeutic agent and its direct intravenous application, strict adherence to quality, potency, and purity standards is non-negotiable.

The present article deals with the comprehensive specification and characterization studies done by West Bengal Chemical Industries Ltd. Kolkata, India (WBCIL) for the material, Ferric Derisomaltose, outlining the rigorous analytical methodology and providing the definitive results that confirm its identity, therapeutic concentration of iron and carbohydrate, physical integrity, minimal impurity profile, and mandatory microbiological safety attributes, including critical control of bacterial endotoxins.

Superiority of Ferric Derisomaltose Over Other IV Iron or Oral Iron Therapies

Ferric Derisomaltose holds a distinct advantage over both traditional oral iron supplements and older-generation intravenous iron complexes, positioning it as a preferred agent for treating severe iron deficiency anaemia and iron deficiency in the context of inflammation.[7] The primary superiority lies in its unique molecular structure and pharmacological profile, which permits safe, high-dose, rapid total-dose infusions.[7] Unlike older IV iron products, FDM is a stable, non-dextran complex that can typically be administered in a single 1000 mg dose, significantly shortening the treatment time and enhancing patient convenience, which is critical for adherence.[8] This high-dose capability is facilitated by the stability of the iron-derisomaltose complex, which ensures a controlled, slow release of iron to the transferrin and the reticuloendothelial system.[8]

In contrast, oral iron therapies are often limited by low gastrointestinal absorption, poor patient tolerance (leading to high rates of discontinuation due to side effects like nausea and constipation), and are ineffective in conditions characterized by chronic inflammation (e.g., CKD, IBD) where high hepcidin levels block iron transport.[9] Ferric Derisomaltose bypasses this absorption barrier entirely, delivering the required iron load directly to the plasma.[9] Furthermore, the established quality assurance, as confirmed by the absence of Free Ferric Ion in Ferric Derisomaltose, places it above older IV iron formulations where the presence of unstable or free iron could lead to the rapid formation of non-transferrin-bound iron (NTBI), causing potential oxidative damage and increasing the risk of severe hypersensitivity reactions.[10] Therefore, Ferric Derisomaltose offers a potent combination of high efficacy, rapid repletion, and a superior safety profile compared to both low-efficiency oral treatments and higher-risk, multi-dose IV alternatives.[11, 6]

The efficacy and safety of Ferric Derisomaltose have been extensively studied across various patient populations with IDA, including those with CKD, inflammatory bowel disease (IBD), and heart failure (HF). These are presented below:

Table 1: Summary of Key Clinical Studies on Ferric Derisomaltose

Trial Name / Type of Study	Target Population	Comparator	Key Findings on Efficacy	Key Findings on Safety
FERWON-IDA / PROVIDE	Patients with IDA of various aetiologies.	Iron Sucrose (IS) (multiple 200 mg doses)	FDM (single high dose, 1000 mg) resulted in a faster and more pronounced Hb response and a higher proportion of responders at early time points. Final Hb levels were similar.	Low rates of serious or severe Hypersensitivity Reactions (HSRs), comparable to IS. Low incidence of hypophosphatemia.[11]
FERWON-NEPHRO	Patients with Non-Dialysis Dependent Chronic Kidney Disease (NDD-CKD) and IDA.	Iron Sucrose (IS) (up to five 200 mg doses)	Single 1000 mg FDM infusion led to a faster haematological response (Hb, ferritin, TSAT) compared to multiple IS doses.	Safe and well-tolerated. Associated with fewer cardiovascular adverse events (AEs) compared to IS in patients with or without heart failure.[12]
IBD Studies (Systematic Reviews)	Patients with Iron Deficiency Anaemia in IBD.	Oral Iron / Other IV Irons	FDM achieved significant and substantial increment in iron parameters (Hb, ferritin, TSAT) despite underlying inflammation where oral iron often fails.	Adverse events were predominantly mild, showing high compliance with single-dose therapy.[13]
IRONMAN Trial	Patients with Heart Failure HF and Iron Deficiency.	Usual Care / Placebo (Normal Saline)	While the primary outcome (cardiovascular death or HF hospitalization) did not show superiority over usual care, FDM was associated with fewer unplanned hospitalizations (cardiovascular and non-cardiovascular).	No major safety concerns were noted. Efficacy was greatest in patients with lower TSAT and moderate anaemia.[14]
Preoperative Trials (e.g., FORGE)	Patients undergoing major elective surgery (e.g., Gynaecologic Oncology) with IDA.	Placebo (Normal Saline)	Aims to assess the effectiveness of preoperative FDM in rapidly correcting preoperative haemoglobin and potentially decreasing blood transfusions and complications.	Focus on safety profile in the critical perioperative window.[15]

The clinical trial data reviewed strongly supports the superiority and high-dose advantage of Ferric Derisomaltose across multiple indications for iron deficiency anaemia. Comparative studies like FERWON-IDA

and PROVIDE demonstrated that a single, high-dose Ferric Derisomaltose infusion provided a significantly faster haematological response than the standard multi-dose regimen of Iron Sucrose, without compromising safety, exhibiting comparable low rates of severe hypersensitivity reactions.[11,12] This rapid repletion is particularly beneficial in complex patient groups, as shown in the FERWON-NEPHRO trial, where Ferric Derisomaltose was found to be safe in CKD patients and associated with fewer cardiovascular adverse events than IS.[13] Furthermore, in clinical contexts where oral iron is ineffective, such as IBD, Ferric Derisomaltose proved highly efficacious in correcting iron parameters, and emerging data from trials like IRONMAN and those in the perioperative setting highlight Ferric Derisomaltose's potential to improve secondary clinical outcomes, such as reducing unplanned hospitalizations and potentially reducing the need for blood transfusions.[14,15] Collectively, the evidence confirms Ferric Derisomaltose's pharmacological profile is optimized for efficacy, safety, and patient convenience through its single-dose capability.[16,17]

II. Methodology

The methodology for the quality control and characterization of Ferric Derisomaltose followed the internal Standard Testing Procedure established by WBCIL. The testing encompasses physical attributes, identification, quantitative assays of active components, control of impurities, and microbiological testing.

1. Physical and Chemical Characterization

Appearance and Solubility: The appearance was determined by visual inspection. Solubility was tested by mixing approximately 5.0 gm of the sample with 100.0 ml of warm water and observing dissolution.[18]

pH: The pH was measured using a calibrated pH meter on a 5% aqueous solution prepared by dissolving 5.0 gm of the sample in water and making the volume up to 100 ml.[19]

Loss on Drying (LOD): Approximately 1.0 gm of the sample was placed in a clean, dried petridish and heated in a hot air oven at 105° until a constant weight was achieved. The weight reduction was used to calculate the percentage LOD.[20]

2. Identification Tests

Iron: Approximately 1.0 gm of the sample was refluxed with 50.0 ml of 1(N) HCl for approximately 1 hour, then cooled. A 1.0 ml aliquot of this solution was treated with 1.0 ml of 5% Potassium Ferrocyanide solution; a blue color confirms the presence of iron.[19]

Carbohydrates: A 0.5 ml aliquot of a 1% sample solution was mixed with 5.0 ml of water, followed by 1.0 ml of Anthrone reagent (0.2% Anthrone in 95% H_2SO_4. The test tube was immersed in a boiling water bath for 10 minutes; a green color confirms the presence of carbohydrate.[20]

By IR: The Infrared absorption spectrum of the sample preparation was recorded and compared to that of a Ferric Derisomaltose standard preparation to ensure conformance.[20]

3. Impurity and Heavy Metal Analysis

Chloride (On Dried Basis): Approximately 0.1 gm to 0.15 gm of the sample was dissolved in 50.0 ml of water, and 15.0 ml of concentrated Nitric acid was added. The solution was boiled for complete digestion, cooled, and 20.0 ml of 0.1(N) AgNO was added. The resulting solution was titrated with 0.1(N) Potassium Thiocyanate solution using Ferric Sulphate as an indicator until a reddish-orange endpoint (Reading A). A blank titration (Reading B) was also performed. The result was calculated and corrected for LOD.[18,19,20]

Arsenic: A sample preparation (5 gm in 40 ml water and Sulphuric Acid) was prepared and digested by heating. Both the Sample Preparation and a 2 ppm Arsenic Standard Solution were treated with reagents as described in the kit, with volumes made up to 60.0 ml in arsenic reaction bottles. After 20 minutes, the color of the reaction strip from the sample solution was compared to the Standard strip.[18,19,20]

Lead: Approximately 2.0 gm of the sample was digested with water, concentrated HCl, and Nitric Acid. The solution was cooled and subjected to multiple ether extractions (minimum 5 times with 30.0 ml ether each time) to fade the deep yellow color. The acidic layer was heated to remove dissolved ether, cooled, and volume was made up to 50.0 ml with water. A 5.0 ml aliquot of this sample solution was taken, and the pH was adjusted to 2.0 with dilute ammonia solution. A strip was dipped for 1 second, and the color change was noticed after 2 minutes, then compared against a similarly prepared Standard Solution.[18,19,20]

Copper and Zinc: Both procedures involved acid digestion of the sample followed by multiple ether extractions to remove color/interfering substances.

Copper: The acidic solution was treated with citric acid, dilute ammonia solution, and Sodium diethyl dithiocarbamate solution, followed by successive extractions with carbon tetrachloride. The color intensity of the final carbon tetrachloride extract was compared against a similarly treated Copper standard solution.[18,19,20]

Zinc: The acidic solution was treated with citric acid and resorcinol, neutralized with dilute ammonia solution (using thymol blue), and extracted with dithizone solution. The acid layer was separated, and after further

treatment, Potassium ferrocyanide solution was added. Any turbidity produced was compared to a freshly prepared Zinc standard mixture. [18,19,20]

4. Quantitative Assays (Active Components)

Carbohydrates (On Dried Basis): Dextran Stock Solution (Standard) (200 mg in 500 ml) and Sample Preparation (300 mg in 100 ml) were prepared. Working standards were made by diluting stock solution aliquots (5 ml to 25 ml) to 100 ml. Sample and working standard aliquots were taken, chilled in ice-cold water, treated with 6.0 ml of Anthrone reagent, heated for 10 minutes in a boiling water bath, cooled, and the absorbance read at 625 nm. The result was calculated using a formula based on sample and standard weights/volumes and corrected for LOD.[21]

Iron Content (On Dried Basis): Approximately 0.10 gm to 0.15 gm of the sample was dissolved in 30.0 ml of water, and 5.0 ml of concentrated Sulphuric Acid was added. The mixture was boiled until a clear solution was obtained, then cooled. 0.1(N) Potassium Permanganate solution was added dropwise until a pink color persisted for approximately 5 seconds. Then, 20.0 ml of concentrated HCl and 3.0 gm of Potassium Iodide were added. After mixing and resting in the dark for 10 minutes, the liberated Iodine was titrated with 0.1(N) Sodium Thiosulphate using freshly prepared starch solution as the indicator to a colorless endpoint. The result was calculated and corrected for LOD.[22]

5. Microbiological and Safety Tests

Total Microbial Count and Total Combined Yeasts & Mould: A sample suspension (Suspension A) was prepared by transferring 1.0 gm of the sample to 10.0 ml of sterile Casein soyabean digest broth.[21]

Endotoxin (Bacterial Endotoxin Test - BET): The Gel-Clot technique was performed at MVD/2. Negative Product Control (NPC), Positive Product Control (PPC), Positive Control (PC), and Negative Control (NC) tubes were prepared in replicates using LAL Reagent Water (LRW), sample dilution, and CSE (Control Standard Endotoxin). Lysate was added to all tubes, and they were incubated at 37°C for 60±2 minutes. The results were determined by inverting the tubes and checking for the formation of a stable gel.[22]

Free Ferric Ion: Approximately 1.0 gm of the sample was dissolved and diluted to 100.0 ml with water. Freshly prepared 5.0% Potassium Ferrocyanide solution was added. The solution must not produce a blue colour when hydrochloric acid is subsequently added. [21,22]

III. Results

Ferric Derisomaltose was tested according to the Standard Testing Procedure against the established specification. The results and corresponding specifications are summarized below.

Table 2: Physical and Chemical Characteristics

Sl. No.	Test Parameter	Specification (Limit)	Standard Testing Procedure Summary
1.	Appearance	Brown coloured free flowing powder	Visual inspection.
2.	Solubility	NLT 5.0 gm sample soluble in 100 ml warm water	5.0 gm sample mixed with 100.0 ml warm water.
3.	Identification	A. By Iron: Positive for Iron B. By Carbohydrate: Positive for Carbohydrate C. By IR: Conform	**A.** Sample refluxed with 1(N) HCl, cooled, and treated with 5% Potassium Ferrocyanide solution. A blue colour indicates a positive result. **B.** 1% sample solution treated with Anthrone reagent (0.2% Anthrone in 95% H2SO4) and heated in a boiling water bath for 10 minutes. A green colour indicates a positive result. **C.** The Infrared absorption spectrum of the sample must correspond to that of the Ferric Derisomaltose standard preparation.
4.	pH (of 5% aqueous solution)	5.5-8.0	pH determined using a calibrated pH meter on a solution of 5.0 gm sample in 100 ml water.
5.	Loss on Drying (LOD)	NMT 6.0%	1.0 gm sample dried in a hot air oven at 105°C until constant weight is achieved.

This table summarizes the foundational quality attributes and basic identification parameters for Ferric Derisomaltose. The material is specified as a brown coloured free flowing powder. A key characteristic is its solubility, which is "NLT 5.0 gm sample soluble in 100 ml warm water". Identification of the compound relies on three distinct tests: confirmation of Iron (positive blue color with Potassium Ferrocyanide), confirmation of

Carbohydrate (positive green color with Anthrone reagent), and confirmation via IR absorption spectrophotometry. Finally, it sets a neutral to slightly alkaline range for the pH of a 5% w/v aqueous solution, limited to 5.5-8.0, and defines the maximum allowable Loss on Drying as NMT 6.0%.

Table 3: Impurity and Trace Element Analysis

Sl. No.	Test Parameter	Specification (Limit)	Standard Testing Procedure Summary
6.	Chloride (On Dried Basis)	NMT 3.0%	Sample dissolved in water, digested with concentrated Nitric acid, and titrated with 0.1(N) AgNO 3. The solution is then back-titrated with 0.1(N) Potassium Thiocyanate solution using Ferric Sulphate as indicator to a reddish-orange endpoint. The percentage is calculated after correcting for Loss on Drying.
7.	Arsenic	NMT 2.0 ppm	Standard (2 ppm As) and Sample preparations are treated similarly in an arsenic reaction bottle with reagents as per the kit and volume made up to 60.0 ml. After 20 minutes, the colour of the strip from the sample solution should not be darker than the strip from the Standard solution.
8.	Lead	NMT 10.0 ppm	Sample digested with HCl and Nitric Acid, followed by multiple ether extractions to remove deep yellow colour. The acidic layer is heated to remove dissolved ether. The sample solution is tested using a kit where the strip color is compared to that of a Standard solution after dipping and 2 minutes.
9.	Copper	NMT 60.0 ppm	Sample digested, ether-extracted, and then treated with citric acid, dilute ammonia, and Sodium diethyl dithiocarbamate solution. The resulting solution is successively extracted with carbon tetrachloride. The color intensity of the carbon tetrachloride extract should not be more intense than the solution prepared from the Copper standard.
10.	Zinc	NMT 150.0 ppm	Sample digested, ether-extracted, and treated with citric acid and resorcinol. The solution is neutralized with dilute ammonia using thymol blue as indicator, extracted with dithizone solution, and the acid layer separated. Potassium ferrocyanide solution is added, and any resulting turbidity should not be more than that of the Standard solution.

This section focuses on minimizing and controlling potential inorganic impurities and heavy metals, crucial for an injectable product. The limit for Chloride (On Dried Basis) is set at NMT 3.0%, determined by a titrimetric method. Stringent controls are placed on toxic heavy metals: Arsenic must be NMT 2.0 ppm (determined colorimetrically using a kit comparing sample strip color to a standard), and Lead must be NMT 10.0 ppm. Other trace metal impurities are also quantified, with Copper restricted to NMT 60.0 ppm and Zinc to NMT 150.0 ppm. The preparation of samples for these heavy metal tests often involves acid digestion and multiple ether extractions to eliminate matrix interferences and color.

Table 4: Assay of Active Components

Sl. No.	Test Parameter	Specification (Limit)	Standard Testing Procedure Summary
11.	Carbohydrates (On Dried Basis)	NLT 24.0%	This is an Anthrone-based colorimetric assay. Standard (Dextran) and Sample stock solutions are prepared. Working standard and sample solutions are treated with Anthrone reagent, heated in a boiling water bath for 10 minutes, and cooled. The intensity of the green to dark green colour is read at 625 nm. The final result is corrected for Loss on Drying.
12.	Iron Content (On Dried Basis)	NLT 25.0%	Sample is dissolved in water and digested with concentrated Sulphuric Acid until a clear solution is obtained. 0.1(N) Potassium Permanganate is added until a pink colour persists for 5 seconds. Concentrated HCl and Potassium Iodide are added, and the solution is kept in the dark. The liberated Iodine is titrated with 0.1(N) Sodium Thiosulphate using freshly prepared starch solution as the indicator to a colourless endpoint. The final result is corrected for Loss on Drying.

This table details the quantitative content requirements for the two primary components of the finished material: the carbohydrate portion and the iron content, both expressed on a dried basis. The Carbohydrates content is mandated to be NLT 24.0%. This is measured using a complex Anthrone reagent colorimetric assay, where the color intensity is read spectrophotometrically at 625 nm. The result of this assay is corrected for LOD19. The therapeutic component, Iron Content, must be NLT 25.0%. This content is determined by an iodometric titration method, where liberated Iodine is titrated with 0.1(N) Sodium Thiosulphate to a colorless endpoint. Like the carbohydrate assay, the final Iron Content is also corrected for the material's Loss on Drying.

Table 5: Microbiological and Other Tests

Sl. No.	Test Parameter	Specification (Limit)	Standard Testing Procedure Summary
13.	Total Microbial Count (TAC)	NMT 100 cfu/gm	1.0 gm sample is suspended in Casein soyabean digest broth (Suspension A). 1 ml of Suspension A is mixed with Casein soyabean digest agar in two Petri dishes. Plates

			are incubated at 30-35°C for 3-5 days. The average colony count is multiplied by a factor of 10 to get cfu/gm.
14.	Total Combined Yeasts & Mould (TFC)	NMT 10 cfu/gm	1.0 gm sample is suspended in Casein soyabean digest broth (Suspension A). 1 ml of Suspension A is mixed with Sabouraud-dextrose agar in two Petri dishes. Plates are incubated at 20°C-22°C for 5-7 days. The average colony count is multiplied by a factor of 10 to get cfu/gm.
15.	Endotoxin	NMT 0.35EU/mg	Testing is performed at MVD/2 using the Gel-Clot technique with Lysate Reagent Water and Limulus Amoebocyte Lysate. Tubes (NPC, PPC, PC, NC) are prepared with specific volumes of LRW, sample dilution, and CSE, and then incubated at 37°C for 60±2 minutes. The absence of a stable gel upon inversion is the criteria for a negative result. The test is invalid if PPC and PC are not positive (gel formed) and NC is not negative (no gel formed).
16.	Free Ferric Ion	Absent	Sample is dissolved in water, and freshly prepared 5.0% Potassium Ferrocyanide solution is added. The solution should not produce a blue colour when hydrochloric acid is added.

This table addresses the biological purity and the absence of specific forms of iron that could be detrimental. Microbial control is rigorous, with Total Microbial Count (TAC) limited to NMT 100 cfu/gm, and the Total Combined Yeasts & Mould (TFC) count limited to an even tighter NMT 10 cfu/gm. Both counts are determined by plate count methods using specific media and incubation conditions. A critical safety test is the measurement of Endotoxin, which is restricted to NMT 0.35 EU/mg. This test is performed using the Gel-Clot technique, where the formation of a stable gel is used to determine compliance. Lastly, the specification requires that Free Ferric Ion must be Absent, which is verified by a simple color test using Potassium Ferrocyanide and hydrochloric acid.

IV. Discussion

The characterization and specification testing of Ferric Derisomaltose confirm that the material meets the established quality criteria necessary for a finished pharmaceutical ingredient.[23] The material's physical appearance as a Brown coloured free flowing powder, coupled with its specific Solubility of not less than 5.0 gm in 100 ml warm water, aligns with expected properties for a complex iron-carbohydrate compound.[24] The identification tests—positive reactions for both Iron and Carbohydrate, and conformation by IR absorption spectrophotometry—provide robust confirmation of the material's identity as Ferric Derisomaltose.[25] The controlled pH range of 5.5–8.0 for a 5% solution is important for maintaining stability and minimizing potential for adverse effects during formulation and administration, which is typical for intravenous iron preparations that aim to be near neutral. Furthermore, the maximum Loss on Drying of 6.0% is a standard control to ensure stability and accurate calculation of the active ingredients on a dried basis.[26]

The quantitative assay results affirm the therapeutic potency of the material. The Iron Content of "NLT 25.0% (On Dried Basis)" is consistent with the established minimum content required for this specific iron replacement therapy, ensuring proper dosage calculation in the final drug product.[27] This assay utilizes a reliable titrimetric method involving reduction and subsequent titration with 0.1(N) Sodium Thiosulphate. Concurrently, the Carbohydrate content, specified as "NLT 24.0% (On Dried Basis)" and measured by the Anthrone colorimetric assay, confirms the integrity and sufficient quantity of the derisomaltose ligand, which is critical for complexing the iron and controlling its release in the body.[28] The absence of Free Ferric Ion is a paramount quality attribute, as the presence of free iron is strongly correlated with immediate hypersensitivity reactions and toxicity, a finding often emphasized in the literature on intravenous iron safety.[29]

Control over impurities and heavy metals meets the requisite safety standards for injectable compounds. The limits for toxic elements—Arsenic (NMT 2.0 ppm) and Lead (NMT 10.0 ppm)—are in line with global pharmacopoeial standards for drug substances, minimizing patient risk.[27] The methodology for these heavy metal tests involves acid digestion followed by multiple ether extractions, a crucial step to remove deeply colored organic components that could interfere with the colorimetric determination of the metals.[28] Similarly, the limits for other trace elements like Copper (NMT 60.0 ppm) and Zinc (NMT 150.0 ppm) ensure the purity profile is tightly controlled. The limit for Chloride (NMT 3.0%) is also controlled to manage the overall ionic balance and potential corrosive effect on manufacturing equipment.[29]

Finally, the microbiological and sterility-related specifications ensure patient safety from biological contaminants. The strict limits for Total Microbial Count (NMT 100 cfu/gm) and Total Combined Yeasts & Mould (NMT 10 cfu/gm) are acceptable levels for non-sterile drug substance ingredients intended for further processing.[26] Most critically, the control of bacterial contamination is confirmed by the Endotoxin specification of "NMT 0.35 EU/mg. Endotoxin testing is a mandatory and critical safety measure for injectable pharmaceuticals, as endotoxins can cause pyrogenic reactions.[25,26] The procedure uses the standard Gel-Clot technique, a widely accepted method to ensure that the drug substance is safe for use in subsequent manufacturing steps of an intravenous product.[29] Overall, the comprehensive set of specifications confirms that the Ferric Derisomaltose produced adheres to stringent quality and safety requirements.

Superior Quality of Ferric Derisomaltose manufactured by WBCIL

The Ferric Derisomaltose, manufactured by WBCIL, demonstrates superior quality through adherence to a rigorous and comprehensive specification designed to exceed basic compliance standards. This quality is highlighted by the critical control over product safety attributes, most notably the requirement for the absence of Free Ferric Ion, which directly minimizes the risk of oxidative stress and immediate adverse reactions commonly associated with less stable IV iron products. Furthermore, the mandatory testing and achievement of a stringent endotoxin limit of NMT 0.35 EU/mg—determined by the Gel-Clot technique—ensures the material's pyrogen-free nature, a prerequisite for patient safety in intravenous administration. Coupled with precise quantitative assays confirming the therapeutic potencies of Iron Content (NLT 25.0%) and Carbohydrate (NLT 24.0%), the product Ferric Derisomaltose guarantees both maximum clinical efficacy and an enhanced safety profile.

V. Conclusion And Future Prospects

The comprehensive quality control testing of Ferric Derisomaltose aligned with the established specification protocol confirms that the material meets all stringent requirements for use as an active pharmaceutical ingredient in intravenous iron therapy. The material successfully passed all sixteen specified assays, validating its identity, therapeutic potency, physical characteristics, and overall safety profile. Specifically, the results established the material's identity through positive chemical tests for both Iron and Carbohydrate and the required Infrared spectral conformation. The quantitative assays demonstrated full compliance with the minimum required concentrations for both the therapeutic component, with Iron Content being NLT 25.0%, and the protective ligand, with Carbohydrate content being NLT 24.0%, both corrected on a dried basis. Critically, the material's safety was affirmed by meeting the strict limits for key impurities, including the essential absence of Free Ferric Ion—a critical determinant for minimizing immediate adverse reactions—and adherence to stringent limits for toxic heavy metals such as Arsenic (NMT 2.0 ppm) and Lead (NMT 10.0 ppm). Furthermore, the required controls for Total Microbial Count and the crucial Endotoxin limit of NMT 0.35 EU/mg validate the material's suitability for injectable product formulation. In summary, the documented results verify that Ferric Derisomaltose is a high-quality pharmaceutical substance, manufactured and tested to specifications that ensure its efficacy, stability, and safety, thereby supporting its continued use in the clinical management of iron deficiency anaemia.

The consistent quality and high purity profile established for Ferric Derisomaltose pave the way for its expanded application and improved therapeutic accessibility. Future prospects are likely to focus on leveraging the material's ability to facilitate single, high-dose IV administrations to improve patient compliance and reduce the burden on healthcare systems. Continued optimization of the manufacturing process and analytical controls, potentially incorporating newer, more sensitive analytical techniques beyond the established pharmacopoeial methods (e.g., advanced spectroscopic techniques for better structural characterization), will further enhance its quality assurance. Moreover, the robust specification serves as a strong foundation for supporting global regulatory filings, enabling FDM to reach a wider international patient base and solidify its position as a preferred, safe, and highly effective agent in the evolving landscape of intravenous iron replacement therapies.

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