Simplified Solution: Store `ingredients` as Codable Structs

Instead of making `Ingredient` and `Instruction` separate SwiftData `@Model` entities, **you can keep them as simple `Codable` structs** inside the `Recipe` model.

Updated `Recipe` Model

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```swift
import SwiftData
import Foundation

@Model
final class Recipe: Codable, Identifiable {
    @Attribute(.unique) var id: Int
    var name: String
    var ingredients: [Ingredient] // Directly store as an array
    var instructions: [Instruction] // Directly store as an array
    var image: String
    var difficulty: String
    var rating: Double
    var cuisine: String
    var prepTimeMinutes: Int
    var cookTimeMinutes: Int
    var reviewCount: Int

    // MARK: - Initializer
    init(id: Int, name: String, ingredients: [Ingredient], instructions: [Instruction
        self.id = id
        self.name = name
        self.ingredients = ingredients
        self.instructions = instructions
        self.image = image
        self.difficulty = difficulty
        self.rating = rating
        self.cuisine = cuisine
        self.prepTimeMinutes = prepTimeMinutes
        self.cookTimeMinutes = cookTimeMinutes
        self.reviewCount = reviewCount
    }

    // MARK: - Codable Conformance
    enum CodingKeys: String, CodingKey {
        case id, name, ingredients, instructions, image, difficulty, rating, cuisine,
    }

    required convenience init(from decoder: Decoder) throws {
        let container = try decoder.container(keyedBy: CodingKeys.self)
        let id = try container.decode(Int.self, forKey: .id)
        let name = try container.decode(String.self, forKey: .name)
        let image = try container.decode(String.self, forKey: .image)
        let difficulty = try container.decode(String.self, forKey: .difficulty)
        let rating = try container.decode(Double.self, forKey: .rating)
        let cuisine = try container.decode(String.self, forKey: .cuisine)
        let prepTimeMinutes = try container.decode(Int.self, forKey: .prepTimeMinutes
        let cookTimeMinutes = try container.decode(Int.self, forKey: .cookTimeMinutes
        let reviewCount = try container.decode(Int.self, forKey: .reviewCount)

        // Directly decode `[Ingredient]` and `[Instruction]`
        let ingredientsStrings = try container.decode([String].self, forKey: .ingredi
        let instructionsStrings = try container.decode([String].self, forKey: .instru

        let ingredients = ingredientsStrings.map { Ingredient(name: $0) }
        let instructions = instructionsStrings.map { Instruction(step: $0) }

        self.init(id: id, name: name, ingredients: ingredients, instructions: instruc
    }

    func encode(to encoder: Encoder) throws {
        var container = encoder.container(keyedBy: CodingKeys.self)
        try container.encode(id, forKey: .id)
        try container.encode(name, forKey: .name)
        try container.encode(ingredients.map { $0.name }, forKey: .ingredients)
        try container.encode(instructions.map { $0.step }, forKey: .instructions)
        try container.encode(image, forKey: .image)
        try container.encode(difficulty, forKey: .difficulty)
        try container.encode(rating, forKey: .rating)
        try container.encode(cuisine, forKey: .cuisine)
        try container.encode(prepTimeMinutes, forKey: .prepTimeMinutes)
        try container.encode(cookTimeMinutes, forKey: .cookTimeMinutes)
        try container.encode(reviewCount, forKey: .reviewCount)
    }
}

// MARK: - Codable Ingredient & Instruction Structs
struct Ingredient: Codable, Hashable {
    var name: String
}

struct Instruction: Codable, Hashable {
    var step: String
}
```

Why This Works & Why It's Easier

✅ **No manual JSON encoding/decoding needed** – CoreData supports storing arrays of `Codable` structs natively.
✅ **Less complexity** – No need for separate `@Model` classes for `Ingredient` and `Instruction`.
✅ **More Swift-friendly** – Directly store `ingredients: [Ingredient]`, which is much cleaner than `ingredientsData: String`.
✅ **Automatic mapping** – The decoder maps `[String]` into `[Ingredient]` with `map { Ingredient(name: $0) }`.

How to Use This Model

Saving a Recipe

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```swift
let context = ModelContext.shared // Your SwiftData context

let recipe = Recipe(
    id: 1,
    name: "Spaghetti Carbonara",
    ingredients: [Ingredient(name: "Pasta"), Ingredient(name: "Eggs"), Ingredient(nam
    instructions: [Instruction(step: "Boil pasta"), Instruction(step: "Cook bacon"),
    image: "carbonara.jpg",
    difficulty: "Medium",
    rating: 4.5,
    cuisine: "Italian",
    prepTimeMinutes: 10,
    cookTimeMinutes: 20,
    reviewCount: 100
)

context.insert(recipe)

do {
    try context.save()
    print("Recipe saved successfully!")
} catch {
    print("Failed to save: \(error.localizedDescription)")
}
```

Fetching Recipes

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```swift
let fetchDescriptor = FetchDescriptor<Recipe>()

do {
    let recipes = try context.fetch(fetchDescriptor)
    for recipe in recipes {
        print("Recipe Name: \(recipe.name)")
        print("Ingredients: \(recipe.ingredients.map { $0.name })")
        print("Instructions: \(recipe.instructions.map { $0.step })")
    }
} catch {
    print("Fetch failed: \(error.localizedDescription)")
}
```

What Does `convenience` Mean in Initializers?

You asked about `convenience init(from decoder:)`. Here's why we use it:

What `convenience` Does:

1. **Required for `NSManagedObject` and `@Model` classes**
   - `@Model` classes **must** call a designated initializer (`init(...)`).