TITLE

Formulation and Quality Evaluation of Multi-Component Vital Q Nutraceutical Capsules for Diabetes and Hypertension.

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Abstract

Chronic non-communicable diseases (NCDs) such as diabetes mellitus and hypertension pose significant global health challenges and often require multifaceted therapeutic approaches. Nutraceutical formulations containing bioactive phytoconstituents offer complementary benefits due to their antioxidant, anti-inflammatory, and cardioprotective properties. This study aimed to formulate and evaluate a capsule preparation combining curcumin, coenzyme Q10, and allicin, designated Vital Q capsules, and assess their pharmaceutical quality. Capsules were prepared using hard gelatin shells and evaluated for physicochemical properties (pH, moisture content, weight uniformity), disintegration time, dissolution profile, and compatibility of actives by Fourier Transform Infrared (FTIR) spectroscopy. The formulation exhibited acceptable pharmaceutical properties (pH 7.23 ± 0.21; moisture content 1.06 ± 0.5% w/w; mean weight 1120.26 ± 0.17 mg) and rapid disintegration (3 min 20 sec). Dissolution studies demonstrated efficient release (>90%) of bioactives within 45 minutes. Comparative FTIR analysis confirmed the presence and compatibility of all active ingredients without evidence of significant interaction. These results indicate that the developed formulation meets critical quality attributes for oral nutraceuticals and may support the management of metabolic disorders. Further in vivo and clinical studies are recommended to validate therapeutic efficacy.

Keywords
Curcumin, Coenzyme Q10, Allicin, Nutraceutical formulation, Hard gelatin capsules, Diabetes mellitus, Hypertension.

1. Introduction

Chronic non-communicable diseases (NCDs) are long-term health conditions including cardiovascular disease, diabetes mellitus, cancer, and chronic respiratory disorders, and collectively account for approximately 74% of global mortality [1,2]. Diabetes mellitus is a metabolic disorder characterized by persistent hyperglycaemia resulting from impaired insulin secretion or action. Type 2 diabetes represents about 95% of cases and is strongly linked to insulin resistance, obesity, and sedentary lifestyle. [3–5] Chronic hypertension, defined as sustained elevation of blood pressure above 130/80 mmHg, predisposes individuals to adverse cardiovascular events including myocardial infarction and stroke. [6,7]

Although conventional pharmacotherapy reduces disease progression, chronic use may involve adverse effects or incomplete control of metabolic parameters. [8] Nutraceuticals derived from botanical and natural sources have drawn attention for their multi-targeted benefits and lower side effect profiles. Curcumin, the principal polyphenol from *Curcuma longa*, exhibits potent anti-inflammatory and metabolic regulatory effects [9,10]. Coenzyme Q10 is a lipid-soluble mitochondrial cofactor with antioxidant and cardioprotective properties. [11,12] Allicin, a sulfur-containing compound from *Allium sativum*, demonstrates antihypertensive and lipid-modulating effects. [13,14]

The combination of these bioactives in a single dosage form may provide synergistic benefits. Capsules are a suitable oral delivery system due to ease of administration, dose accuracy, and rapid release characteristics. [15,16] Therefore, this study aimed to develop and evaluate a nutraceutical capsule formulation — Vital Q containing curcumin, coenzyme Q10, and allicin.

2. Materials and Methods

2.1 Materials

Curcumin (95% purity) was obtained from Medkoo Bioscience Inc., USA. Coenzyme Q10 (99% purity) was procured from Inner Mongolia Kingdomway Pharmacy, China. Allicin (95% purity) was supplied by Allimin Pharma, Telangana, India. Hard gelatin capsules were purchased from Komal Pharma, Ahmedabad, India. All reagents were analytical grade.

2.2 Capsule Formulation Composition

Bioactive Constituent	Quantity per Capsule
Allicin	500 mg
Coenzyme Q10	100 mg
Curcumin	500 mg

Table 1 Capsule Formulation Composition

Quantities were selected based on literature indicating therapeutic relevance in metabolic regulation.

2.3 Preparation of Capsules

Capsules were prepared using a semi-automatic capsule-filling machine (Brothers Cap 2000SA9). Actives were accurately weighed and blended using geometric dilution to ensure homogeneity. The blend was then filled into size “000” hard gelatin capsules. Capsules were visually inspected to ensure proper sealing and absence of leakage, and stored at 20–25°C with ~50% relative humidity until evaluation.

2.4 Physicochemical Evaluation

2.4.1 Organoleptic Evaluation
Organoleptic properties (colour, odour, taste, appearance) were assessed by visual and sensory inspection.

2.4.2 pH Measurement
A 1% w/v aqueous solution of capsule contents was prepared, and pH was measured using a calibrated digital pH meter.

2.4.3 Moisture Content
Moisture content was determined by the loss on drying method. Cups containing 1 g sample were dried until constant weight.

2.4.4 Uniformity of Weight
Twenty capsules were individually weighed on an analytical balance, and mean ± SD was calculated.

2.4.5 Disintegration Test
Capsules were tested in distilled water at 37 ± 0.5°C using a USP disintegration apparatus. The endpoint was defined as the absence of residue on the mesh.

2.5 Dissolution Testing
Dissolution studies were performed using USP Dissolution Apparatus II (paddle method) at 37 ± 0.5°C and 100 rpm with 900 mL of phosphate buffer pH 6.8 as dissolution medium. Samples were withdrawn at predetermined intervals (5, 10, 20, 30, and 45 min), filtered, and analyzed spectrophotometrically at 430 nm.

2.6 FTIR Spectroscopy
FTIR studies were conducted to assess the chemical compatibility of the actives and to confirm the presence of characteristic functional groups. Spectra of pure curcumin, CoQ10, allicin, and the Vital Q formulation were recorded using an IRSpirit SHIMADZU FTIR spectrometer (ATR mode), scanning from 4000 to 400 cm^{-1} at 4 cm^{-1} resolution. Spectra were analyzed using LabSolutions IR software.

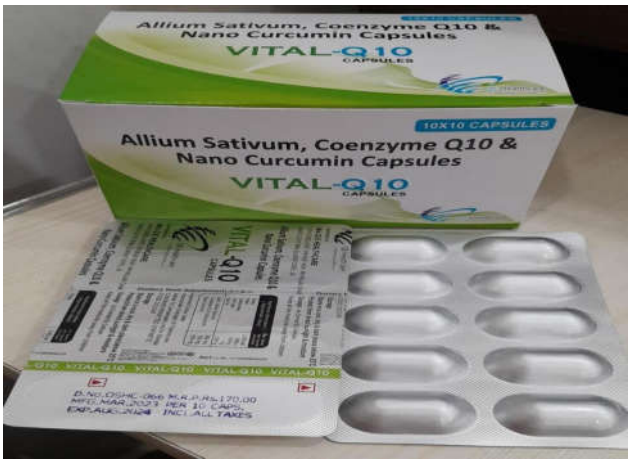

Table 2 VITAL-Q10 Capsules

3. Results

3.1 Physicochemical Evaluation

Parameter	Result
pH	7.23 ± 0.21
Moisture content	1.06 ± 0.5 % w/w
Uniformity of weight	1120.26 ± 0.17 mg
Disintegration time	3 min 20 sec

Table 3 Physicochemical Evaluation of the Capsule

The formulation exhibited acceptable physicochemical attributes consistent with immediate-release nutraceutical capsules.

3.2 Dissolution Profile

The dissolution study demonstrated consistent release of bioactive components, with all samples releasing >90% of active contents within 45 minutes.

4. FTIR Spectroscopy and Compatibility

FTIR spectra confirmed characteristic functional group peaks of curcumin, coenzyme Q10, and allicin. The overlay spectrum of the Vital Q formulation retained the major peaks corresponding to:

Functional Group	Standard Peak (cm^{-1})	Capsule Peak (cm^{-1})	Interpretation
O–H stretching (phenolic)	3500–3600	3567–3587	Phenolic hydroxyl groups
C–H stretching (alkane)	2850–2950	2826–2981	Aliphatic hydrocarbon chains
C=O stretching (carbonyl)	1700–1735	1716–1734	Carbonyl functional groups
C=C stretching (aromatic)	1500–1625	1507–1625	Aromatic ring vibrations
C–O stretching	1000–1100	1012–1053	Ether / phenolic linkages
C–S / Sulfoxide stretching	930–1030	≈1032	Sulfur-containing groups (Allicin)

Table 4 FTIR spectral analysis

No significant shifts or disappearance of peaks were observed, indicating chemical compatibility of the actives within the formulation.

5. Discussion

The Vital Q capsules demonstrated robust pharmaceutical performance across evaluated parameters. The near-neutral pH and low moisture content enhance stability and minimize degradation or microbial contamination. Uniform weight and rapid disintegration ensure consistent dosing and efficient release under physiological conditions.

The dissolution profile is appropriate for immediate release forms, with >90% release by 45 minutes, suggesting that the bioactives are readily available for absorption.

FTIR analysis provided chemical confirmation that the active ingredients retain their functional groups in the formulation and do not interact negatively with each other or with excipients.

Retention of characteristic peaks without shift corroborates molecular stability and compatibility.

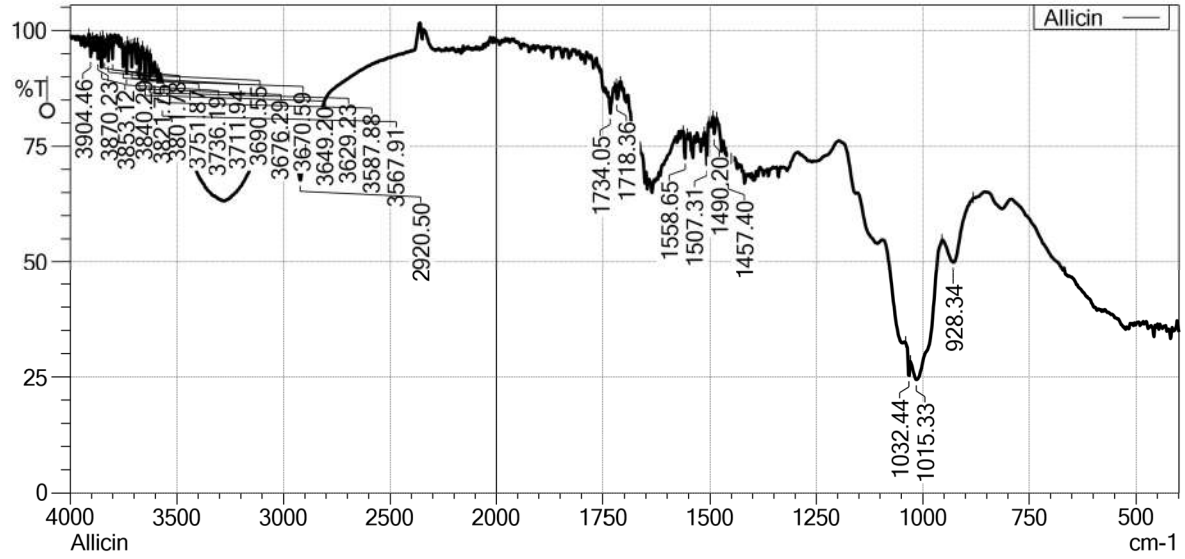

Figure 1 FTIR spectra of Allicin

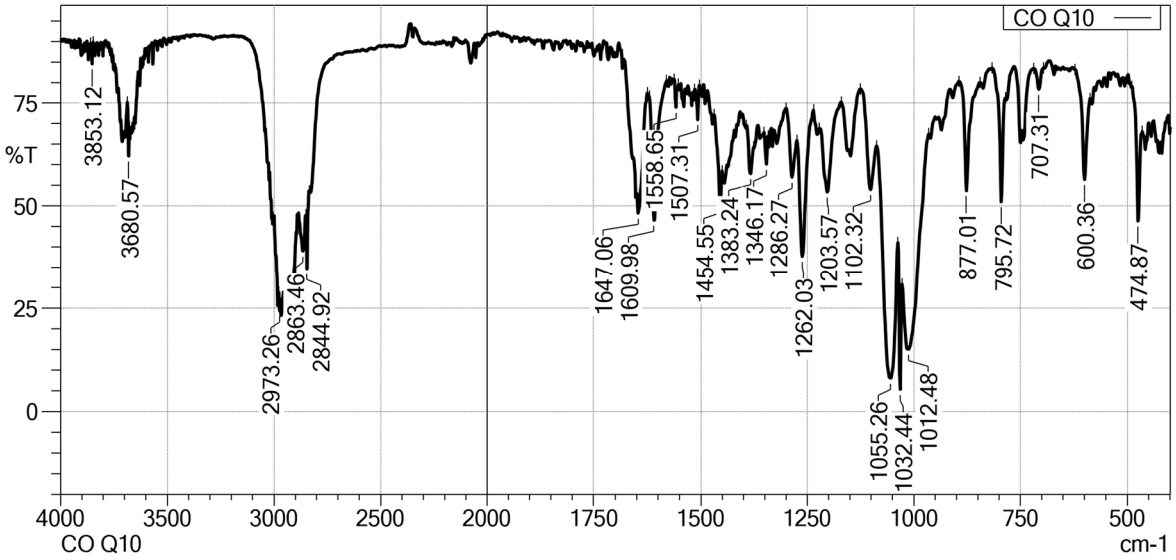

Figure 2 FTIR Spectra of Co-enzyme Q10

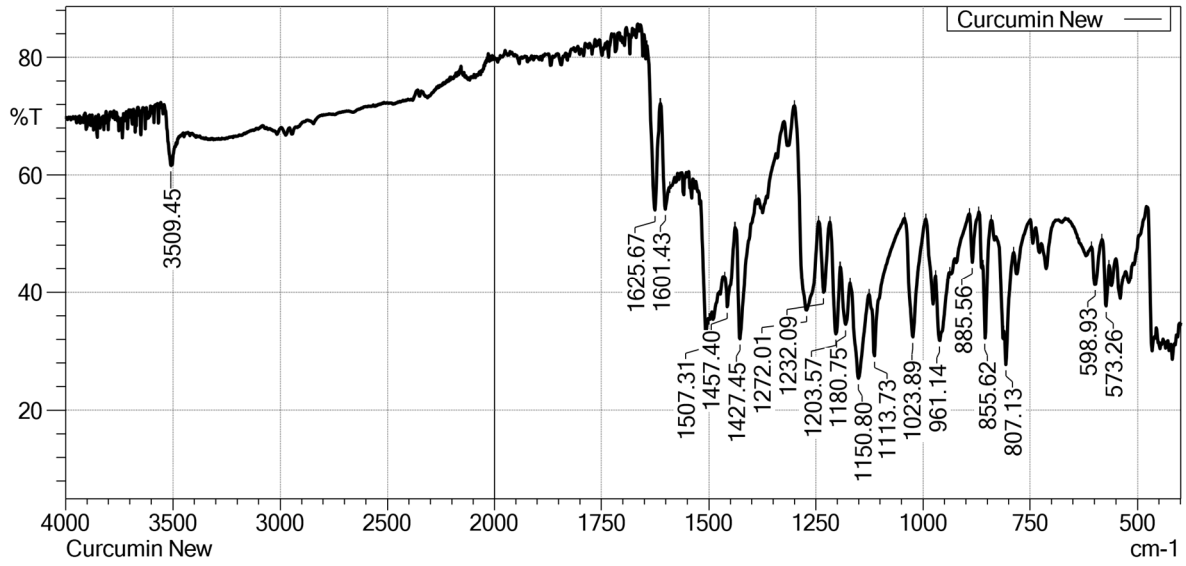

Figure 3 FTIR Spectra of Curcumin

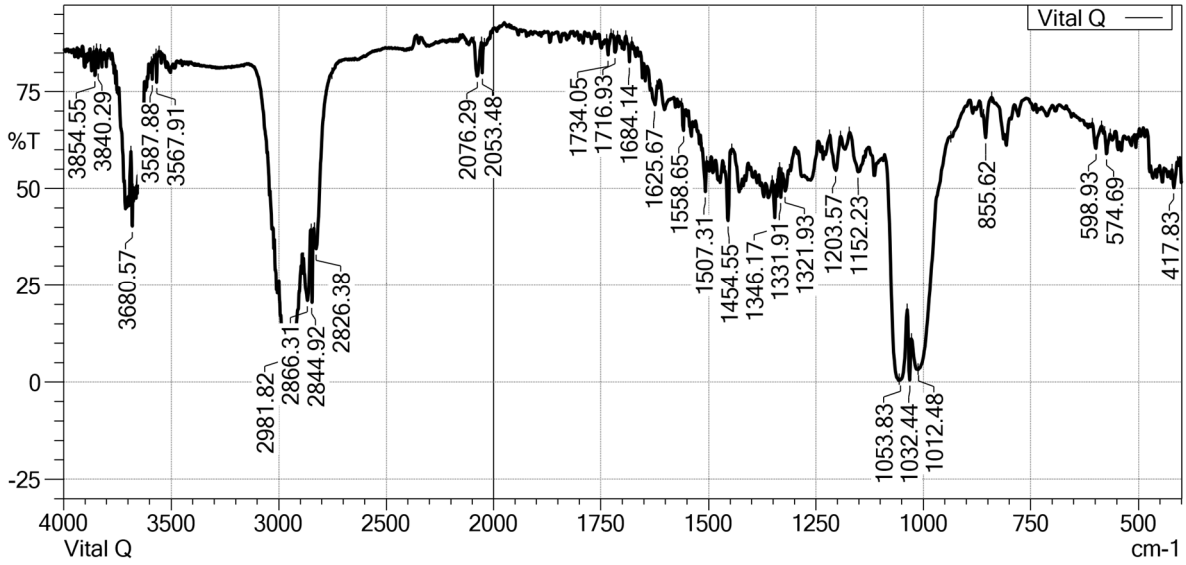

Figure 4 FTIR Spectra of Vital Q capsule

6. Conclusion

The developed Vital Q capsules containing curcumin, coenzyme Q10, and allicin meet essential quality attributes for nutraceutical oral dosage forms, exhibiting acceptable physicochemical properties, rapid disintegration, and efficient dissolution. FTIR spectroscopy confirmed compatibility and structural integrity of the active constituents within the formulation. These results indicate that the formulation is pharmaceutically sound and suitable for further development as a nutraceutical for supportive management of metabolic disorders such as diabetes mellitus and hypertension. Future in vivo studies and clinical trials are required to confirm therapeutic efficacy and long-term safety.

7. References

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