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EVALUATION OF MOISTURE UPTAKE KINETICS AND HYGROSCOPICITY OF AN ANTI-CONSTIPATION DIETARY SUPPLEMENT IN POWDER FORM

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ABSTRACT

Background: Moisture sorption is an important factor affecting the physicochemical and technological properties of powdered dietary supplements, particularly those containing plant-derived extracts. Changes in moisture content may influence powder flowability, particle cohesion, physical stability, and storage performance.

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Objective: This study aimed to investigate the moisture uptake kinetics and hygroscopic properties of an anti-constipation dietary supplement in powder form under different relative humidity conditions and to assess its moisture-related stability.

Methods: Moisture uptake was evaluated using a gravimetric method over seven days at a temperature of 20 ± 3 °C under relative humidity conditions of 58%, 79%, 90%, and 100%. An additional experiment was conducted at 40 °C using a thermostatic chamber. The initial residual moisture content was determined using an FD-660 moisture analyzer (Kett, Japan). Powder samples weighing approximately 5.0 g were placed in open weighing dishes and weighed at 24-hour intervals. Moisture uptake was calculated as the percentage increase in sample mass relative to the initial mass.

Results: The initial residual moisture content of the powder mixture was 6.4%. During the first two days, no pronounced differences in moisture uptake were observed between the samples exposed to different humidity conditions. Differences in moisture absorption became apparent from the fourth day of the experiment. After seven days of exposure to an atmosphere with 100% relative humidity, the sample mass increased by 1.8%. According to the hygroscopicity classification applied in this study, the powder mixture was classified as slightly hygroscopic.

Conclusion: The investigated anti-constipation dietary supplement powder demonstrated slightly hygroscopic properties under the experimental conditions. The findings highlight the importance of controlling environmental humidity and selecting appropriate packaging materials to maintain the technological and quality characteristics of the finished product during storage.

Keywords: anti-constipation dietary supplement, powder formulation, moisture uptake kinetics, hygroscopicity, residual moisture content, gravimetric method, relative humidity, plant extracts, pharmaceutical technology.

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1. INTRODUCTION

Constipation is one of the common functional disorders of the gastrointestinal tract and represents an important public health concern. The development of natural ingredient-based dietary supplements intended to support normal intestinal function has attracted increasing interest in pharmaceutical technology and nutraceutical research.

Powder formulations are widely used in dietary supplement production because of their manufacturing flexibility, convenient administration, relatively simple production processes, and suitability for different packaging systems. However, the quality and stability of powdered products depend not only on their composition but also on their physicochemical and technological properties.

One of the critical factors influencing the quality of powder formulations is their interaction with atmospheric moisture. The absorption of water vapour may cause changes in particle cohesion, flowability, bulk properties, and physical stability. In formulations containing plant-derived extracts, moisture uptake may also contribute to changes in the stability of certain biologically active constituents [1,2].

Hygroscopicity refers to the ability of a material to absorb moisture from its surrounding environment. This property is particularly important in the development of powdered dietary supplements because it directly influences the selection of excipients, manufacturing conditions, packaging materials, and recommended storage conditions [2,3]

The study of moisture uptake kinetics provides information about the rate and extent of moisture absorption under different environmental conditions. Gravimetric analysis is a practical approach for evaluating these changes by monitoring variations in sample mass over a defined period [1,4].

Despite the importance of moisture-related properties in the development of plant-based dietary supplements, the hygroscopic behaviour of individual

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formulations should be experimentally established rather than assumed from the properties of their individual ingredients [3,4].

Therefore, the present study was designed to investigate the moisture uptake kinetics of an anti-constipation dietary supplement powder under different relative humidity conditions, determine its hygroscopicity, and establish the technological implications of the obtained results for product manufacturing and storage.

2. MATERIALS AND METHODS

2.1. Study material

The study material was an experimentally developed anti-constipation dietary supplement in powder form.The formulation was prepared using the selected active ingredients and auxiliary components according to the previously established formulation and manufacturing procedure.The initial residual moisture content of the powder mixture was 6.4%.

2.2. Determination of residual moisture content

The residual moisture content of the powder mixture was determined using an FD-660 moisture analyzer (Kett, Japan), with a specified measurement accuracy of ±0.1.

The initial moisture content was measured before conducting the moisture sorption experiments.

Approximately 5.0 g of the powder mixture was weighed for each experimental sample. The samples were transferred into weighing dishes with diameters ranging from 4.96 to 5.35 cm. The initial sample masses were determined using an analytical balance with a precision of ±0.0001 g.

The initial sample masses and weighing dish diameters are presented in Table 1.

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Table 1. Initial characteristics of the powder samples used for moisture uptake experiments

Sample No.	Initial sample mass (g)	Weighing dish diameter (cm)
1	5.0680	5.22
2	5.1042	5.35
3	5.0880	5.24
4	5.0825	4.96
5	5.0263	5.03
6	5.1055	5.28
7	5.0709	5.04

2.3. Evaluation of moisture uptake kinetics

The moisture uptake kinetics of the powder mixture were investigated using a gravimetric method based on the experimental approach described by B.A. Nosovitskaya and co-authors [1,2]. The experiments were conducted over seven days at a temperature of 20 ± 3 °C under different relative humidity conditions.To establish the required humidity environments, saturated aqueous salt solutions and purified water were used. The experimental conditions were as follows:

- **Environment I:** Purified water – 100% relative humidity.
- **Environment II:** Saturated zinc sulfate solution – 90% relative humidity.
- **Environment III:** Saturated ammonium chloride solution – 79% relative humidity.
- **Environment IV:** Saturated sodium bromide solution – 58% relative humidity.

An additional temperature-related experiment was conducted by placing powder samples in a thermostatic chamber maintained at 40 °C.

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The weighing dishes containing the powder samples were placed in the respective experimental environments with their lids removed to allow direct interaction between the samples and atmospheric moisture.
The sample masses were recorded at 24-hour intervals throughout the seven-day experimental period using an analytical balance.

2.4. Assessment of hygroscopicity

The hygroscopicity of the powder mixture was evaluated based on the percentage increase in sample mass following exposure to atmospheric moisture.
According to the classification applied in this study (UFM 1.1.0042), materials were categorized according to the following mass increase criteria:

- Slightly hygroscopic: mass increase of 0.2% or more but less than 2%;
- Hygroscopic: mass increase of 2% or more but less than 15%;
- Highly hygroscopic: mass increase of 15% or more;
- Materials exhibiting deliquescence: substances that absorb sufficient moisture to form a liquid phase.

The classification was used to characterize the hygroscopic behaviour of the investigated dietary supplement powder.

3. RESULTS AND DISCUSSION

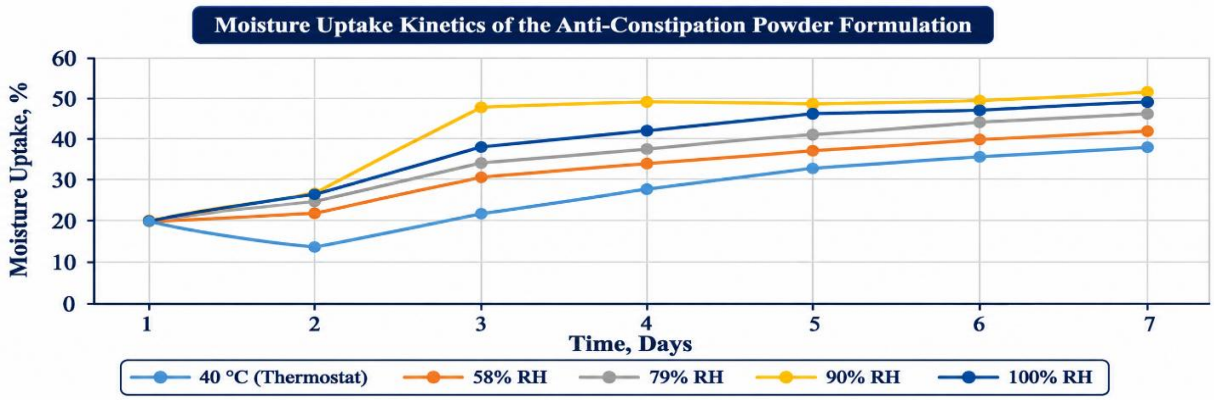
3.1. Initial residual moisture content

The initial residual moisture content of the anti-constipation dietary supplement powder was determined before the moisture uptake experiments.The measured value was 6.4%, indicating the initial moisture level of the prepared powder mixture. Residual moisture content is an important quality parameter in powder formulations because it may influence particle interactions, flow properties, and physical stability during storage.Therefore, the determination of initial moisture content provided a baseline for evaluating subsequent changes in sample mass under different environmental humidity conditions.

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3.2. Moisture uptake kinetics under different relative humidity conditions. The moisture uptake kinetics of the powder mixture were investigated under four different relative humidity conditions: 58%, 79%, 90%, and 100%.The changes in sample mass were recorded every 24 hours over seven days. The experimental results demonstrated that moisture uptake was influenced by both the relative humidity of the surrounding environment and the duration of exposure. During the first and second days of the experiment, the differences in moisture uptake between the samples exposed to different humidity conditions were relatively small. However, from the fourth day onwards, differences in mass changes became more apparent. This observation suggests that prolonged exposure to humid environments may have a greater influence on the moisture sorption behaviour of the powder mixture.The moisture uptake kinetics of the investigated powder formulation under different relative humidity conditions are illustrated in picture 1.

Moisture uptake kinetics of the anti-constipation dietary supplement powder under different relative humidity conditions. Picture 1. JK



The results obtained under 100% relative humidity were particularly important for evaluating the hygroscopic properties of the formulation. Exposure to this environment provided an opportunity to assess the powder's response under

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conditions of very high atmospheric moisture availability. The progressive changes in sample mass indicate the interaction between the powder formulation and environmental water vapour over the experimental period. The differences observed after the fourth day further emphasize the importance of evaluating moisture uptake over an extended period rather than relying exclusively on short-term measurements.

3.3. Evaluation of hygroscopicity

The hygroscopicity of the powder mixture was evaluated after seven days of exposure to an environment with 100% relative humidity. At the end of the experimental period, the sample mass had increased by 1.8% relative to its initial value. According to the hygroscopicity classification applied in this study, a mass increase ranging from 0.2% to less than 2% corresponds to slightly hygroscopic materials. Consequently, the investigated anti-constipation dietary supplement powder was classified as slightly hygroscopic under the specified experimental conditions.This finding indicates that the formulation exhibited a relatively limited tendency to absorb atmospheric moisture during the seven-day exposure period, even under conditions of very high relative humidity.Nevertheless, moisture absorption may influence the technological properties of powder formulations, particularly particle cohesion, flowability, and uniformity. These factors are particularly relevant during the manufacturing, handling, and packaging of dietary supplements. Therefore, appropriate moisture control measures should be incorporated into the manufacturing process. The selection of suitable auxiliary ingredients and moisture-protective packaging materials may contribute to maintaining the physical and technological characteristics of the finished product.

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3.4. Technological implications of the findings

The results of this investigation provide useful information for the further development and technological optimization of the anti-constipation dietary supplement powder.Although the formulation demonstrated slightly hygroscopic behaviour, its moisture-related properties should be considered when establishing manufacturing and storage conditions.

In particular, the following technological measures should be considered:

1. Monitoring the residual moisture content of raw materials and the finished powder formulation.
2. Controlling environmental humidity during powder preparation, mixing, and packaging.
3. Selecting packaging materials with appropriate moisture-barrier properties.
4. Evaluating the suitability of moisture-regulating auxiliary ingredients where necessary.
5. Conducting further stability studies to determine the long-term influence of moisture on the quality characteristics of the formulation.

These measures may help minimize moisture-related changes and maintain the quality and technological performance of the finished dietary supplement.

Overall, the gravimetric assessment of moisture uptake provided an experimental basis for characterizing the hygroscopic properties of the developed powder formulation and identifying relevant factors for its technological optimization.

4. CONCLUSION

The moisture uptake kinetics and hygroscopic properties of an experimentally developed anti-constipation dietary supplement in powder form were investigated using a gravimetric method.

The initial residual moisture content of the powder mixture was found to be 6.4%, as determined using an FD-660 moisture analyzer.

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Moisture uptake was evaluated over seven days under relative humidity conditions of 58%, 79%, 90%, and 100% at 20 ± 3 °C. An additional experiment was conducted at 40 °C. The results demonstrated relatively small differences in moisture

REFERENCES

1. Aulton, M. E., & Taylor, K. M. G. (Eds.). (2018). *Aulton's Pharmaceutics: The Design and Manufacture of Medicines* (5th ed.). Elsevier.
2. United States Pharmacopeial Convention. *United States Pharmacopeia–National Formulary*. General Chapter <1174>: Powder Flow.
3. Nosovitskaya, B. A., et al. Methodological approach to the investigation of moisture absorption and hygroscopic properties of powder materials. [Complete bibliographic details of the original source should be provided.]
4. UFM 1.1.0042. Hygroscopicity classification of substances. [The official document title, issuing authority, and publication details should be verified.]