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Article

# The Potential of Regional Food Product Quince in Powdered Form as a Good Source of Bioactive Compounds

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**Abstract:** (1) Background: The research on the potential of regional food products, known for their rich bioactive compound content, could enhance human health in local populations. This is especially pertinent amid the Covid-19 pandemic and global trade disruptions; (2) Methods: The current study evaluated the physico-chemical composition using standard methods, antioxidant activity via DPPH, ABTS, FRAP, and CUPRAC methods, sorption capacity (at 10°C, 25°C, and 40°C with water activity ranging from 0.1 to 0.9) through the static-gravimetric method, and monolayer moisture content (MMC) calculated using the BET model; (3) Results: The approximate physico-chemical composition of laboratory-produced quince powder is as follows: proteins - 1.27g, carbohydrates - 75.80g, fats - 0.49g, fibers - 21.50g, ash - 2.31g, and nutritional value - 355.65kcal. Antioxidant activity is confirmed by all methods. The Modified Halsey model is recommended to describe the sorption isotherms with an S-shaped form. The MMC for the adsorption process ranges from 14.41% d.b. to 7.09% d.b., and for the desorption process, it ranges from 13.11% d.b. to 7.80% d.b.; (4) Conclusions: Seasonal and regional foods boast the best nutritional profiles, as they are cultivated and harvested at optimal ripeness in natural sunlight, preserving the essential vitamins and minerals in the food.

**Keywords:** quince; powder; flour; bioactive compounds; antioxidant activity; color indicator; adsorption; desorption; monolayer moisture content; sorption isotherms

## 1. Introduction

Common quince (*Cydonia oblonga*), a member of the *Rosaceae* family, boasts bright golden-yellow seeded fruits renowned for their astringency and captivating aroma. Originating from Iran, this distinctive fruit has found its way to various corners of the world, including New Zealand, Greece, France, Argentina, and our Balkan region [1-2]. In terms of appearance, quince fruits share similarities with apples and pears but stand out with their shapelessness and larger size. The yellow-gold surface, sometimes adorned with a mossy covering, contributes to their unique astringent taste, a quality attributed to the presence of antiseptic tannins. Beyond its culinary appeal, quince proves to be a valuable natural health product, combating infections across various body systems [2-4].

Abundant in pectin, cellulose, and essential vitamins (C and B3), as well as vital minerals like phosphorus, calcium, magnesium, and sodium, quince also contains trace amounts of copper, manganese, cobalt, vitamin A, and iron. Notably, the quince bark, enriched with hydroxycinnamic acids and flavonols, exhibits antioxidant properties, including antihemolytic effects [5-6]. Furthermore, quince seeds contain vitamin B17 (laetrile or amygdalin), renowned for its unique anticancer properties. Despite various claims, quince remains most beneficial in its raw, natural form.

A decoction of dried quince leaves has been proven to alleviate coughs and respiratory problems and soothe asthma attacks. [7-8].

In the context of the COVID-19 pandemic and global trade disruptions, the significance of regional food sources becomes increasingly apparent. Seasonal and regional foods, cultivated and harvested at peak ripeness under natural sunlight, retain their essential vitamins and minerals without extensive processing. Opting for local products not only ensures a diet rich in nutrients but also promotes a lifestyle free from preservatives and pesticides [9-10].

It is widely believed that individuals derive the most benefits from consuming characteristic regional foods based on their origin. While experimenting with various foods is encouraged, the body often requires a balance that aligns with one's cultural and regional background. Following the "eat the rainbow" principle by incorporating a variety of fruits and vegetables into our diet provides diverse phytonutrients crucial for overall health. Recent studies recommend including over 25 types of fruits and vegetables weekly to support a diverse microbiome [11-12].

These insights underscore the bioactive potential of regional fruits and vegetables, with specific emphasis on the Bulgarian quince, even if not explicitly highlighted in the existing literature.

## 2. Materials and Methods

### 2.1. Material

Quince (*Cydonia oblonga* Mill.), sourced locally from the village of Smilets near Pazardzhik city, Bulgaria, undergoes a meticulous preparation process. The procedure involves washing, peeling, and drying the fruits. These fruits are sliced into small pieces, approximately 3.0mm to 5.0mm in thickness, with the removal of seeds. The freshly sliced quince is then arranged in a single layer on a Food Dehydrator (Dryer) Machine and subjected to a 10-hour drying period at 45°C, or until the moisture content falls within the range of 9% to 13%, ensuring they attain complete dryness and brittleness. Following the drying phase, the quince slices are finely milled using a Nutri-bullet blender into a powdered form. This entire preparation process takes place at the Technical University of Sofia, branch Plovdiv, Bulgaria.

### 2.2. Methods

The analysis of quince powder involved the assessment of moisture, protein, fat, ash, and dietary fiber content in accordance with established food analysis methods [13]. Specifically, protein content was determined by multiplying the quantified nitrogen using the conversion factor 6.25 (AOAC 920.152). The fat, obtained through Soxhlet, was determined gravimetrically after solvent removal (AOAC 920.85). Ash content was acquired by burning at approximately 550 °C (AOAC 940.26), and dietary fiber was obtained through the enzyme-gravimetric method (AOAC 985.29). Carbohydrates were calculated as the residual fraction. Results are expressed as g/100 g dry weight (dw). The nutritional energy value (kcal/100 g fw and dw) was computed using the following conversion factors: 9 kcal/g for fat, 4 kcal/g for protein and carbohydrates, and 2 kcal/g for fiber.

Color measurements were conducted employing a colorimeter (model PCE-CSM, Germany) with a viewing angle of 0° and a pulsed xenon lamp as the light source. The instrument provides readings in terms of color coordinates, where L\* represents whiteness to darkness, a\* denotes redness to greenness, and b\* signifies yellowness to blue. Instrument calibration was executed using a standard white plate, and samples were positioned on a petri dish for each measurement.

The hue angle (H°) and chromaticity (C) were calculated using the following equations [Eq. 1 and Eq. 2]:

$$H^{\circ} = 360 + \tan^{-1} \left( \frac{b^*}{a^*} \right), \text{ where } b^* < 0 \quad [\text{Eq. 1}]$$

$$C = \sqrt{(a^*)^2 + (b^*)^2} \quad [\text{Eq. 2}]$$

The antioxidant activity of quince powder assessed through DPPH (1,1-diphenyl-2-picrylhydrazyl radical), ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)), FRAP (Ferric Reducing Antioxidant Power Assay), and CUPRAC (CUPric Reducing Antioxidant Capacity), was conducted through a two-step triple extraction. Approximately 1g of the sample was mixed with 10 ml of 70% ethanol and conducted in a water bath at 80 °C. Additionally, using an ultrasonic bath, ultrasonic extraction was carried out at a temperature of 50 °C, repeated three times in 20-minute intervals. After the extraction process, the sample was centrifuged at 6000 rpm for 15 min. The supernatant was transferred to a new tube, and another 10 ml of ethanol was added to the precipitate for the second extraction. After the third extraction, the supernatants were mixed and stored in a refrigerator. The protocol for the methods adhered to the description comprehensively detailed in two articles by Ivanov et al. (2014) and Bogoeva et al. (2017) [14-15].

The characteristics of sorption of Bulgarian quince powder (equilibrium moisture content and monolayer moisture content) are conducted following the specification of the static-gravimetric method (at 10°C, 25°C and 40°C and water activity of 0.1 to 0.9) and the detailed steps describe in the article of Bogoeva, 2020 [16]. For the analysis, the sample undergoes preparation by placing a portion in a desiccator over distilled water for desorption, while another portion is placed in a desiccator over CaCl<sub>2</sub> for adsorption. Following 20 days of hydration of one part and dehydration of the other part, the resulting powder is transferred to aluminum weighing plates and measured (1.0000g ± 0.0050g) using the analytical balance. Hygrostats, consisting of borosilicate glass jars with acrylic plastic lids featuring silicone rings, are prepared for use with saturated salt solutions derived from LiCl, CH<sub>3</sub>COOK, MgCl<sub>2</sub>, K<sub>2</sub>CO<sub>3</sub>, MgNO<sub>3</sub>, NaBr, NaCl, KCl, creating conditions for water activity (*a<sub>w</sub>*) ranging from 0.1 to 0.9. Thymol crystals are introduced into each hygrostat with a water activity exceeding 0.5 to prevent microbiological growth. The weighed samples are then placed in the prepared jars, positioned in three distinct thermostats set at temperatures of 10°C, 25°C, and 40°C. These samples remain in these environments until they reach equilibrium moisture content, typically around one month [16].

Several mathematical models are available for predicting the equilibrium moisture content. To analyze the obtained equilibrium sorption data, four modified three-parametrical models, namely Oswin [Eq. 3], Henderson [Eq. 4], Ching-Pfost [Eq. 5], and Halsey [Eq. 6], were chosen.

$$M = (A + Bt) \left( \frac{a_w}{1-a_w} \right)^C \quad [\text{Eq. 3}]$$

$$1 - a_w = \exp[-A(t + B)M^C] \quad [\text{Eq. 4}]$$

$$a_w = \exp \left[ \frac{-A}{t+B} \exp(-CM) \right] \quad [\text{Eq. 5}]$$

$$a_w = \exp \left[ \frac{-\exp(A+Bt)}{M^C} \right] \quad [\text{Eq. 6}]$$

The equations [Eq. 3, Eq. 4, Eq. 5 and Eq. 6] involve parameters such as moisture content (*M* in % d.b.), water activity (*a<sub>w</sub>* in decimal), and coefficients *A*, *B*, and *C*, with temperature (*t* in °C) playing a role. The fitting of these modified models was executed using the computer program StatSoft's *STATISTICA* 12. Evaluation, estimation, and comparison of the models were performed based on three criteria: mean relative error (*P*%) [Eq. 7], standard error of moisture (*SEM*) [Eq. 8], and randomness of residuals [Eq. 9], according to the equations used of Durakova, 2020 [17].

$$P = \frac{100}{N} \sum \left| \frac{M_i - \hat{M}_i}{M_i} \right| \quad [\text{Eq. 7}]$$

$$SEM = \sqrt{\frac{\sum (M_i - \hat{M}_i)^2}{df}} \quad [\text{Eq. 8}]$$

$$e_i = M_i - \hat{M}_i \quad [\text{Eq. 9}]$$

The monolayer moisture content represents the maximum amount of moisture that the powder can retain on its surface at given temperatures (10°C, 25°C, and 40°C) and relative air humidity ranging from 11% to 87%. The powder remains dry when the moisture content is below the monolayer level, but it can become sticky, clump together, or spoil when it exceeds this level. Calculation of the monolayer moisture content involves the linearization of the Brunauer-Emmett-Teller equation [Eq. 10], where parameters include monolayer moisture content ( $M$  in % d.b.), water activity ( $a_w$  in decimal), and the coefficient  $C$  [16-17].

$$M = \frac{M_e C a_w}{(1-a_w)(1-a_w + C a_w)} \quad [\text{Eq. 10}]$$

### 3. Results & Discussion

#### 3.1. Approximate physico-chemical composition

Quince flour is a versatile product within the food chain, providing a rich source of nutrients and functional compounds. Due to these valuable properties, the nutritional and chemical composition of quince flour has been analyzed.

**Table 1** presents the nutritional composition of quince flour, detailing moisture, fat, protein, ash, dietary fiber, carbohydrates, and energy value. Quince flour primarily consists of carbohydrates (75.80 g/100 g) and is notably high in dietary fiber (21.50 g/100 g). Dietary fiber comprises various carbohydrates that resist hydrolysis or absorption in the human small intestine, contributing to health benefits, especially for gastrointestinal function [18].

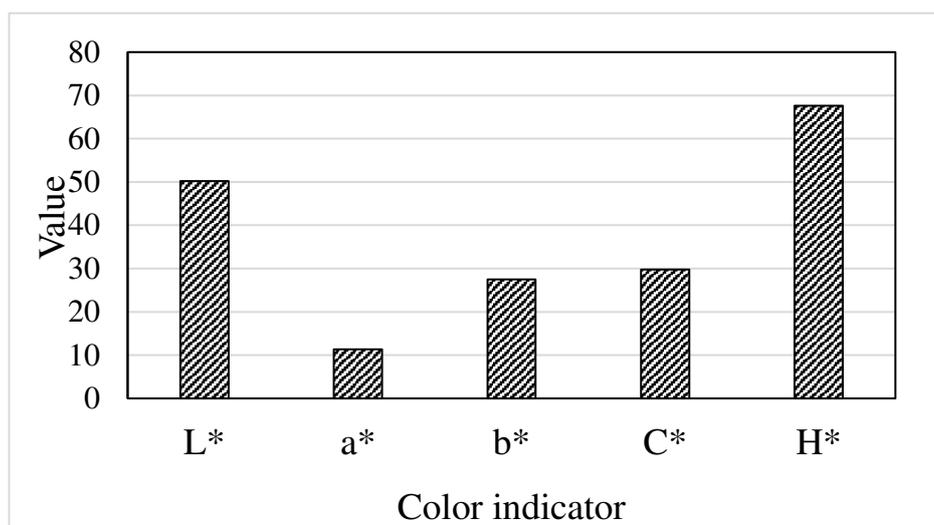
In accordance with European regulations, a food product can claim to be a "source of fiber" if it contains at least 3 g/100 g and "high in fiber" if it contains 6 g/100 g or more [19]. Quince fruit flour, meeting these criteria, can be labeled as "high in fiber." Additionally, the contents of ash (total minerals), protein, and fat are present in smaller amounts, measuring 2.21 g/100 g, 1.27 g/100 g, and 0.49 g/100 g, respectively. The energy value of quince flour is 355.65 kcal.

**Table 1.** Approximate physico-chemical composition and nutritional values of quince powder.

Parameters	Results, g per 100 g of sample
Carbohydrates	75.80±0.28
Ash content	2.31±0.13
Fiber	21.50±1.84
Protein	1.27±0.10
Lipids	0.49±0.12
Nutritional values	355.65±1.07

#### 3.2. Color characteristics

Color parameters are crucial indicators of quality, significantly influencing consumers' willingness to purchase a food product. The instrumental color analysis revealed that quince flour exhibits relatively light characteristics, with a high color brightness value,  $L^* = 50.21$  (**Figure 1**).



**Figure 1.** Color indicators of quince powder.

Higher L\* values do not necessarily indicate a decline in product quality; rather, it may be attributed to the dilution effect of the wall materials [20]. Additionally, recorded parameter values a\* (red color coordinate) and b\* (yellow color coordinate) for quince flour were a\* = 11.35 and b\* = 27.51. The b\* parameter indicates that quince flour particles lean toward the yellow color coordinate. The shade angle (H\*) reflects the characteristic color of the powder, where a hue angle of 0°, 90°, 180°, and 270° represents red, yellow, green, and blue colors, respectively [21]. Quince particles, in this case, exhibited values from the yellow coordinate (67.59±0.38). Furthermore, the color saturation (C\*) of quince flour (29.76±0.53) serves as a measure of color purity.

### 3.3. Antioxidant activity of quince powder

As a food source that is both relatively inexpensive and health-promoting Quince's high polyphenol content makes it well known for its antibacterial and antioxidant qualities [22-25].

In the present study four different methods are used and antioxidant activity of quince powder is detected in all of them. Results are presented in Table 2 as mM Trolox equivalent per gram extract and mM Trolox equivalent per gram dry weight.

**Table 2.** Antioxidant activity of the quince powder.

Method	mMTE/g extract	mMTE/g dry weight
DPPH	65.09±6.80	45.57±4.76
ABTS	8.35±0.07	5.84±0.05
FRAP	4.54±0.33	3.18±0.23
CUPRAC	7.94±1.01	5.56±0.71

The higher result is obtained via DPPH method (65.09±6.80 mMTE/g extract, 45.57±4.76 mMTE/g dry weight). In addition, quince powder was obtained by drying in a food dehydrator, which according to some authors leads to an increase in the content of phenolic compounds and improved antioxidant activity compared to fresh fruit [15, 26-27].

Specifically, because quince fruit has higher levels of phenolic components and a larger antioxidant capacity than apple or pear [28-29], using it as an antioxidant source can be beneficial in nutraceuticals and open up new uses for quince fruit [30]. The powdering method makes it simple to incorporate quince fruit into new food recipes as a nutritional supplement.

### 3.4. Sorption characteristics

### 3.4.1. Equilibrium moisture content

To delve into the sorption characteristics of the laboratory-produced flour derived from the edible part of Bulgarian quince, the investigation initiated with the determination of the initial moisture content, which was identified as 10.14%. Subsequently, the powdered product underwent a controlled cycle of hydration and dehydration conditions over a span of 10 days. Distilled water was employed for the hydration phase, while CaCl<sub>2</sub> was utilized for the dehydration phase.

During the absorption process, meticulous adjustments were made to dehydrate the product, ultimately achieving a moisture content level of 5.52%. In contrast, the desorption process involved a careful hydration regimen, resulting in the attainment of a moisture content level of 26.68%. This specific step is crucial in the overall process as it facilitates the determination of values representing the sorption capacity of the flour.

The outcomes of these processes, elucidating the equilibrium moisture content values, have been meticulously recorded and are presented in detail in **Tables 3 and 4**. These tables serve as comprehensive repositories of the data obtained during the hydration and dehydration cycles, providing valuable insights into the sorption characteristics of the laboratory-produced flour from the edible part of the Bulgarian quince.

**Table 3.** Equilibrium moisture content (M), % dry basis for adsorption at three temperatures *t* (°C) and water activity *a<sub>w</sub>*.

Sel	10°C			25°C			40°C		
	<i>a<sub>w</sub></i>	M*	sd**	<i>a<sub>w</sub></i>	M*	sd**	<i>a<sub>w</sub></i>	M*	sd**
LiCl	0.113	10.25	0.33	0.113	9.37	0.25	0.112	8.00	0.08
CH <sub>3</sub> COOK	0.234	13.37	0.30	0.225	13.22	0.24	0.201	12.77	0.17
MgCl <sub>2</sub>	0.335	16.53	0.32	0.328	13.82	0.14	0.316	13.16	0.05
K <sub>2</sub> CO <sub>3</sub>	0.431	24.00	0.06	0.432	16.61	0.20	0.432	16.91	0.06
MgNO <sub>3</sub>	0.574	27.19	0.11	0.529	20.17	0.28	0.484	17.93	0.22
NaBr	0.622	30.70	0.15	0.576	24.87	0.28	0.532	19.45	0.16
NaCl	0.757	40.54	0.08	0.753	38.29	0.33	0.747	34.89	0.13
KCl	0.868	66.38	0.17	0.843	57.16	0.15	0.823	50.15	0.17

\* Mean value of triple replications, \*\* standard deviation.

**Table 4.** Equilibrium moisture content (M), % dry basis for desorption at three temperatures *t* (°C) and water activity *a<sub>w</sub>*.

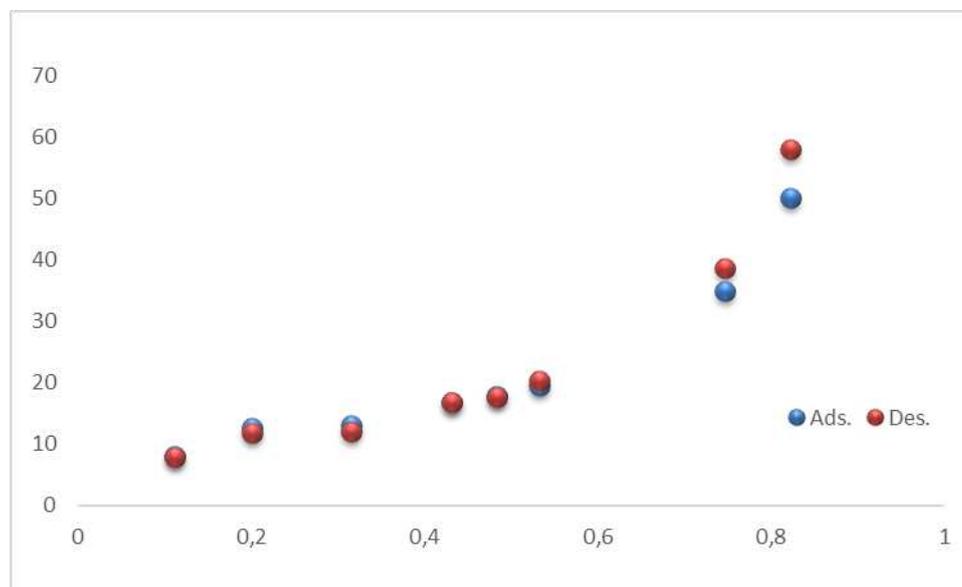
Sel	10°C			25°C			40°C		
	<i>a<sub>w</sub></i>	M*	sd**	<i>a<sub>w</sub></i>	M*	sd**	<i>a<sub>w</sub></i>	M*	sd**
LiCl	0.113	13.76	0.09	0.113	10.34	0.22	0.112	7.90	0.09
CH <sub>3</sub> COOK	0.234	15.43	0.45	0.225	12.05	0.27	0.201	11.89	0.29
MgCl <sub>2</sub>	0.335	16.40	0.48	0.328	13.02	0.13	0.316	12.09	0.20
K <sub>2</sub> CO <sub>3</sub>	0.431	24.11	0.44	0.432	18.29	0.08	0.432	16.88	0.37
MgNO <sub>3</sub>	0.574	25.91	1.09	0.529	19.85	0.21	0.484	17.74	0.11
NaBr	0.622	28.92	0.13	0.576	25.70	0.24	0.532	20.39	0.21
NaCl	0.757	41.46	0.71	0.753	41.28	0.35	0.747	38.68	0.88
KCl	0.868	66.49	1.39	0.843	59.25	0.75	0.823	58.06	1.08

\* Mean value of triple replications, \*\* standard deviation.

In both processes, a behavior typical of a significant number of food products is evident: as the temperature rises while maintaining a constant water activity, there is a notable decrease in the equilibrium moisture content [16-17, 31-33]. This phenomenon is in line with the well-established principle observed in the field.

To visually depict and compare the sorption characteristics, **Figure 2** has been included, showcasing the sorption isotherms under experimental conditions at a temperature of 40°C. The

graphical representation distinctly highlights that the isotherms conform to the characteristics of type II, as per the classification outlined by Brunauer et al. in 1940 [34]. This classification system provides insights into the interaction between moisture content and water activity, further aiding in the understanding of the sorption behavior observed in the laboratory-produced flour from the edible part of the Bulgarian quince.



**Figure 2.** Comparison of isotherms at 40°C.

### 3.4.2. Modified three-parametrical models

The derived coefficients (A, B, C) for the three-parameter models, namely Oswin, Halsey, Henderson, and Chung-Pfost, are meticulously calculated and outlined in Table 5 for the adsorption process and Table 6 for the desorption process. These coefficients play a crucial role in these models, providing insights into the specific characteristics of the sorption behavior observed during both processes.

**Table 5** offers a comprehensive presentation of the calculated coefficients and is complemented by additional parameters such as the mean relative error (P%) and the standard deviation (SEM). These metrics contribute to a more thorough evaluation of the accuracy and reliability of the models employed during the adsorption process.

Similarly, **Table 6** provides a detailed breakdown of the coefficients A, B, and C for the selected three-parameter models, offering a comparative analysis with additional insights into mean relative error (P%) and standard deviation (SEM) for the desorption process. This comprehensive data presentation serves as a valuable reference point for further analysis and interpretation of the sorption characteristics of the laboratory-produced flour from the edible part of the Bulgarian quince.

**Table 5.** Coefficient of modified models (A, B, C), the mean relative error (P%) and the standard error of moisture content (SEM) for adsorption.

Model	A	B	C	P	SEM
Oswin	24.3597	-0.1028	0,5495	11.13	2.39
<b>Halsey</b>	<b>4.19682</b>	<b>-0.0091</b>	<b>1.4246</b>	<b>5.79</b>	<b>2.03</b>
Henderson	0.00017	2.6988	1.6486	26.03	9.30
Chung-Pfost	356.522	0.0655	90.338	17.89	6.19

**Table 6.** Coefficient of modified models (A, B, C), the mean relative error (P%) and the standard error of moisture content (SEM) for desorption.

Model	A	B	C	P	SEM
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Oswin	22.8885	-0.0282	0.5744	14.66	4.27
Halsey	4.31774	-0.0122	1.4329	9.89	3.09
Henderson	0.00014	9.2395	1.6159	21.99	9.71
Chung-Pfost	318.699	0.0637	79.833	21.29	7.29

Figures 3 and 4 depict the graphical representation of the residuals distribution obtained from the calculations of the coefficients of the modified models used in the experiment.

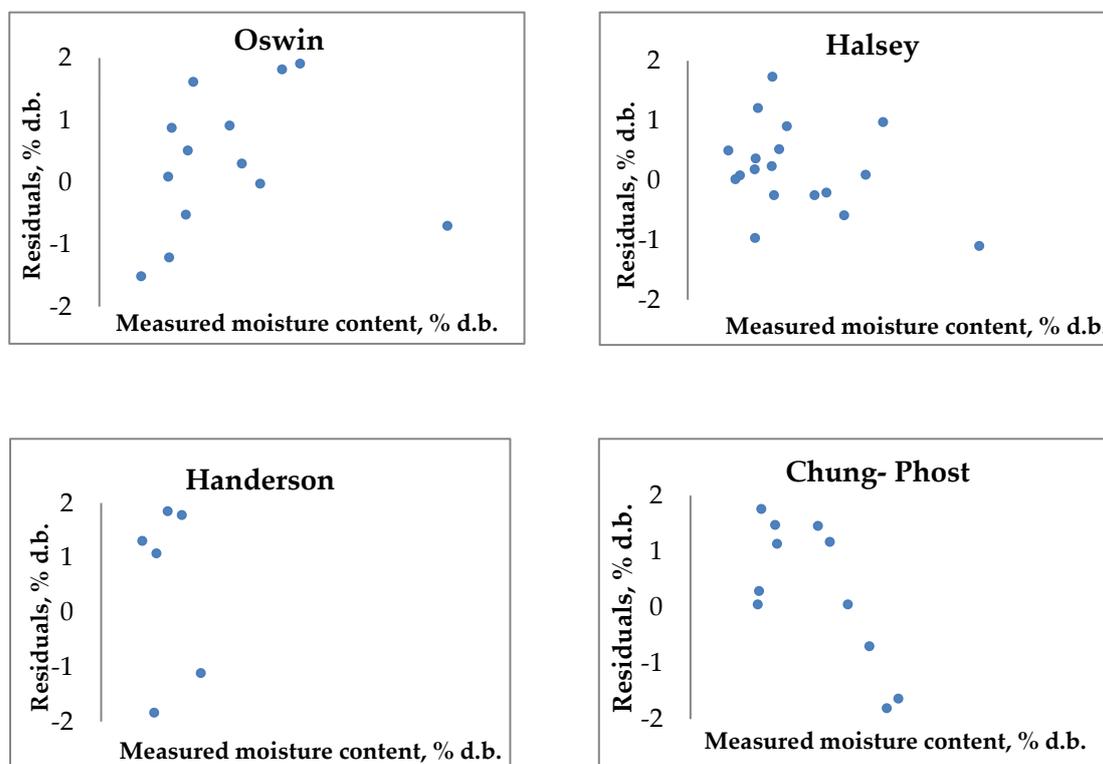
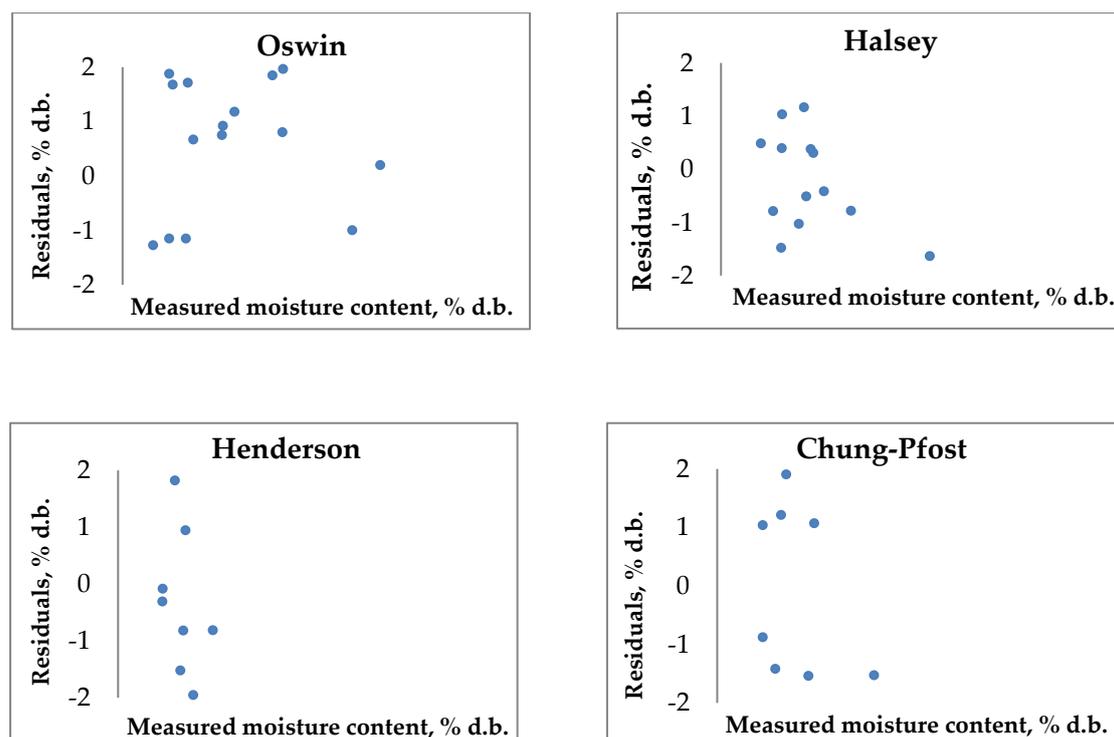


Figure 3. Residues distribution for the processes of adsorption.



**Figure 4.** Residues distribution for the processes of desorption.

Upon thorough examination of the tabular data and graphical dependencies, a discernible pattern emerges, indicating that the modified Halsey model consistently produces the lowest values for both mean relative error (P) and standard deviation (SEM) across both the adsorption and desorption processes. This noteworthy finding underscores the model's superior performance in accurately describing the sorption isotherms of the laboratory-produced flour from the edible part of the Bulgarian quince.

The robustness of the modified Halsey model is further emphasized by its ability to exhibit a random and even distribution of residues in both processes. This characteristic suggests that the model captures the sorption behavior with a high degree of precision, avoiding systematic biases and errors.

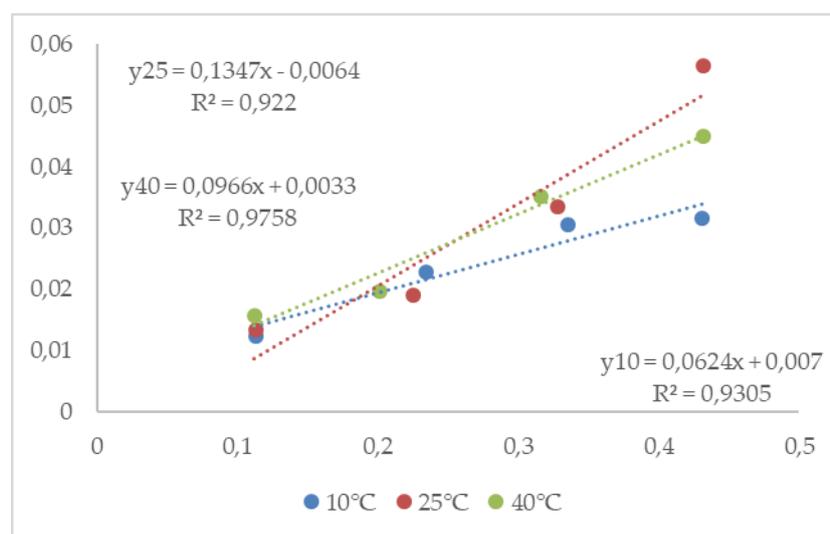
Given these compelling observations, it is strongly recommended to leverage the modified Halsey model as the preferred choice for characterizing the sorption isotherms of flour derived from Bulgarian quince. This model not only demonstrates exceptional accuracy in representing the observed data but also showcases a consistent and reliable performance, making it a valuable tool for further research and analysis in the realm of sorption characteristics of quince-derived products.

### 3.4.3. Monolayer moisture content

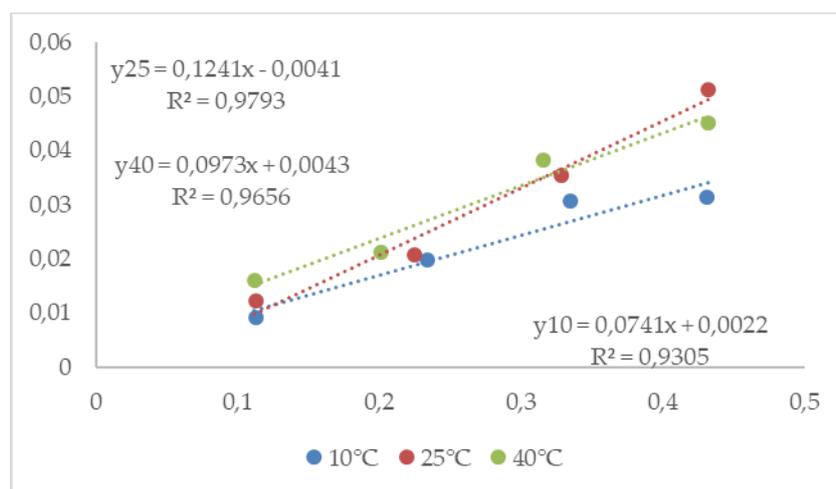
Through the strategic application of linearization techniques, as illustrated in Figs. 5 and 6, the Brunauer-Emmett-Teller equation was adeptly utilized to calculate the monolayer moisture content (MMC) [35]. This analytical process involved utilizing experimental data specifically for water activity ( $a_w$ ) values less than 0.5. The powdered product sourced from the edible part of the Bulgarian quince served as the subject of this meticulous examination, with the outcomes of this analysis being succinctly presented in **Table 7**.

The process of linearization, as depicted in **Figures 5 and 6**, adds a layer of precision to the calculation of the monolayer moisture content. This technique allows for a more nuanced understanding of how the moisture content of the quince-derived product behaves at lower water activity levels, providing valuable insights into its unique sorption characteristics.

The data encapsulated in **Table 7** becomes an invaluable reference point, offering a comprehensive overview of the monolayer moisture content specifically tailored to the conditions of the powdered product from the edible portion of the Bulgarian quince. This analysis enhances our understanding of the product's behavior at low water activity levels, contributing to the broader exploration of its sorption dynamics [35].



**Figure 5.** BET model linearization for the adsorption process.



**Figure 6.** BET model linearization for the desorption process.

**Table 7.** Monolayer moisture content expressed in % dry basis and calculated through BET model.

$t$ (°C)	Adsorption	Desorption
10	14.41% d.b.	13.11% d.b.
25	7.09% d.b.	7.80% d.b.
40	10.01% d.b.	9.84% d.b.

The outcomes of the analysis underscore the significant impact of temperature on the monolayer moisture content (MMC) values in the flour derived from the edible part of Bulgarian quince. The observed variations provide valuable insights into how temperature influences the sorption characteristics of the quince-derived product.

At a temperature of 10°C, the MMC values were 14.41% d.b. for the adsorption process and 13.11% d.b. for desorption. This suggests a heightened moisture absorption and release capacity at this lower temperature range. As the temperature increases to 25°C, a noticeable decline in MMC values is evident, with readings settling at 7.09% d.b. for adsorption and 7.80% d.b. for desorption. This temperature shift results in a moderated sorption capacity compared to the lower temperature range.

Interestingly, the MMC values experience a subsequent rise at a temperature of 40°C, reaching 10.01% d.b. for adsorption and 9.84% d.b. for desorption. This indicates a reinvigorated sorption capacity at higher temperatures, showcasing the dynamic influence that temperature exerts on the moisture content behavior of the quince-derived flour.

These nuanced findings highlight the intricate relationship between temperature and sorption characteristics, offering a detailed perspective on how varying temperature levels impact the monolayer moisture content of the powdered product from the edible part of the Bulgarian quince.

#### 4. Conclusions

Equilibrium moisture content for both adsorption and desorption processes of flour from the edible part of Bulgarian quince were determined at temperatures of 10°C, 25°C, and 40°C, with relative air humidity ranging from 0.11 to 0.85.

It was observed that, with constant water activity, equilibrium moisture content decrease as the temperature increases.

The isotherms of the studied product were classified as type II according to Brunauer et al.'s classification.

The modified Halsey model is recommended to describe the adsorption isotherms of the studied product.

Monolayer moisture content (MMC) values for both adsorption and desorption processes were calculated from the linearization of the Brunauer-Emmett-Teller model, using experimental data for  $a_w < 0.5$ .

The temperature was found to influence the monolayer moisture content (MMC) values of flour from the edible part of Bulgarian quince. The highest MMC value was observed at a temperature of 10°C for both processes, followed by a decrease at 25°C, and an increase again at 40°C.

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