

# Study the Storage Temperature & Periods on Rheological Properties of Wheat Flour

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**Abstract** When increasing the storage temperature from 27.5°C to 37.5°C the water absorption ratio of the flour is significantly increased. Besides, the average ratio of absorption of flour has increased more significantly when increasing storage period from one day to ten days, and by increasing the period of storage from ten days to thirty days, the increase is also significant. The overlap of the two factors of this study has a significant effect on this manner. There has been a significant increase in the time development of the dough at a storage temperature of 37.5°C, compared to 27.5°C. of storage. But, however, there has not been a significant effect of the storage periods or their overlapping with the temperature storage on this manner. It has been observed that the indicator of dough stability is higher when storing the flour under the temperature of 37.5°C in 4.45 minutes, compared with the stability of 2.23 minutes when storing the flour at a temperature of 27.5°C. On the other hand, increasing the period of storage from one day to ten days has led to a significant decrease in the stability of the dough, but in increasing the period to twenty days to thirty days, the high capacity of these would not reach the level of significance. The overlap, however, between these two factors has a significant effect on the stability of the dough.

**Keywords:** storage temperature, rheological properties, wheat flour

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## 1. Introduction

The water absorption is the most important quality factor that concerned the baker and so direct relationship to the amount of bread that can be produced from a given weight of flour, and the absorption of baking the perfect is the maximum amount of water that can be used to get the maximum yield of bread per unit by weight of flour and get recipes trading satisfactory dough during molding (Panning) [1].

During the long period of storage changed exact characteristics of the impact of unsaturated fatty acids, which can reduce the absorption of the water flour [2].

The study has shown [3] that the soft wheat flour heating degree 80°m temperature for 15 minutes showed the possibility to improve it to make bread, as noted a significant increase in time.

The improvement or maturity in flour happen more quickly if you view the exact inventory to ventilation, due to increased ties sulphur amino acids present in the flour proteins and thereby increase the tensile strength flour paste, in addition to the occurrence of oxidation of certain fatty acids and the reduction of some pigments flour is desired, but the oxidation fatty acids led to a decrease in the quality of baking [4,5].

It has been found [6].that the exact absorption of water increases during the exact maturity may be lost as a result of moisture during storage and improve the properties of the chemical bonds of the network gluten self-induced oxidation.

The storage conditions and the length of the storage period are the keys or the main factors that contribute to the stability of the exact storage stability of the flour [7].

Found [8] that the wheat flour is inventory wizard for a year on the degree of heat and 20°C 30°C 40°C ground by extracting 75% have been affected rheological qualities as the results of the farinograph examination pointed out that the main factor affecting the flour oxidation and loss during storage is storage temperature, and that the examination Alviograph indicators during storage in a higher degree of heat 30°C cause a change in the rheological properties of dough, especially on the strength of the dough, while Storage 40° c degree in temperature resulted in an increase in tensile strength the dough, and thus difficulty in baking process.

Purpose of this study was to:

- study the interaction relationship between each of the temperature and duration of storage and their impact on the rheological properties.
- Study the possibility of employing temperatures and periods of storage in grinding wheat flour to find a quality suitable for baking without the use of chemicals improved.

#### Materials and Methods Search:

To achieve the objectives of the research are designed laboratory experiment was carried out in the laboratories of Yemen Company for Grain Silos and Flour Mills Yemen, and using a design method World full of random testing. [9].

#### Study materials:

Raw wheat:

The Class used in the flour to these samples to study is Soft wheat French origin.

Where the production of flour milling after the cleaning stages and Wheat Hydration with water for 24 hours in the company's mills, a modern cylindrical mills Buhler Swiss company.

#### Flour:

The study was conducted on the output flour of grinding And extraction by almost 76%, where according to the standard specifications in the flour.

Production by Moisture does not exceed 14%, by protein not less than 10% Standard Yemeni No. (2005/51) [10].

#### Salt:

Product salt was used in Pakistan carries the name brand (King) containing 0.07% iodide

Potassium, sodium bicarbonate and brosiat yellow soda.

#### Devices used:

1- measuring the temperature and the relative air humidity device (Digital Thermometer MT-2 -) equipped from the KI & BNT company, Chinese.

5- sensitive electronic balance (Analytical Balance 220g) degree of accuracy 0.1 mg- equipped from Sartorius company, Germany.

6- Farinograph Brabender device pelvic with a capacity of 300 gm for difinited rheological characteristics.

7- Exstensograph Brabender device to examine a number of rheological characteristics.

#### Study transactions:

first factor: degrees Storage temperature (A).

1. Adjusting the stored heat to 27.5 Celsius (A1)  $\pm$  0.5.
2. Adjusting the stored heat to 37.5 Celsius (A2)  $\pm$  0.5.

Second factor: intervals Storage

1. Flour stored for a day (B 1).
2. Flour stored for 3 days (B 2).
3. Flour stored for 10 days (B 3).
4. Flour stored for 20 day (B 4).
5. Flour stored for 30 days (B 5).

Flour were collected samples in PP bags of 25 kg capacity at final production line, and stored in a suitable location to provide a degree of storage required temperature by conditioning device talk (split) contains a sensor to measure the temperature and is set to the required degree, has also been measure and control temperature accuracy by a special device that has Tssen together the first to measure the temperature, and the second for measuring relative air humidity.

And study samples have been stored in a small store size of 4 x 4 x 8 meters has been allocated for this purpose with varying degrees of heat A (27.5°C and 37.5°C  $\pm$  0.5) and for different periods of storage B (day, 3 days, 10 days, 20 days, 30 days) and were followed up and record the natural relative humidity percentages, as well as temperatures in the atmosphere storage by six readings per day for the first treatment (temperature 27.5°C) and for the treatment of second (temperature 37.5°C) distributed

at the beginning of the day and the middle and end during the period study (two months), May and June 2009 During the study has a degree Storage temperature 27.5°C A1, and in June and July 2009. The study was conducted on the storage temperature 37.5°C A2 was sufficient here to explain the three readings recorded in the days of access to the storage periods It required a day and 3 days, 10 days and 20 days and 30 days, as it is written in the Table 1 and Table 2.

**Table 1. temperature readings at 27.5° C  $\pm$  0.5, and storage relative air humidity (three readings for each storage period)**

Storage periods Time	Temperature (°C)	Relative humidity %
dayam6.30	27.5	44%
daypm2.30	27.6	48%
daypm8.30	27.0	54%
days3am6.30	27.2	44%
days3pm2.30	27.0	42%
days3pm8.30	27.0	42%
days10am6.30	27.0	40%
days10pm2.40	27.1	43%
days10pm8.00	27.0	40%
days20am6.30	27.0	38%
days20pm2.00	27.0	47%
days20pm8.00	27.3	43%
days30am6.30	27.6	51%
days30pm2.30	27.1	51%
days30pm8.30	27.7	45%
Number of reading recorded	202	202
Average of temperature	27.41°C	

The number of readings taken during the month 202

Average temperatures taken 27.41 m

\* Table showing only readings of temperature and relative humidity weather at the end of each period Storage.

The natural relative humidity ranged between 38- 54%.

**Table 2. temperature readings at 27.5° C  $\pm$  0.5, and storage relative air humidity (three readings for each storage period)**

Storage periods Time	Temperature (°C)	Relative humidity %
dayam6.30	37.9	62%
daypm2.30	37.0	49%
daypm8.30	37.0	47%
days3am6.30	37.5	51%
days3pm2.30	37.0	48%
days3pm8.30	37.8	51%
days10am6.30	36.8	66%
days10pm2.40	37.0	70%
days10pm8.00	37.6	51%
days20am6.30	37.3	56%
days20pm2.00	37.2	60%
days20pm8.00	37.4	56%
days30am6.30	37.0	48%
days30pm2.30	38.00	40%
days30pm8.30	37.8	54%
Number of reading recorded	176	176
Average of temperature	37.42 °C	

The number of readings taken during the month 176.

Average temperatures taken 37.42 °C

\* Table showing only readings of temperature and relative humidity weather at the end of each period Storage,

The natural relative humidity ranged between 48- 70% studied traits.

## 2. Results and Discussion

The impact of degrees Storage temperature and epochs on the rheological properties:

Farinograph characteristics:

Absorbency ratio of flour to water:

Some pointed references [11,12,13] that the behavior rheology wheat flour to the dough of great importance in making bread flour ratio of the absorption of water, the duration of kneading, dough development time and dough stability is of great importance in study the impact of raw materials used in the baking industry, and therefore the final product quality. The results indicated in Table 3 to the existence of significant differences in the proportion of flour absorption of water stored under degrees Storage temperature under study, where the high temperature of 27.5°C to 37.5°C average absorption rate are significantly increased from 59.26% to 60.54%. This indicates the presence of the effect of the degree of storage on the proportion of water absorption in flour stored heat.

The data show that at the same table storage periods under study influenced significant effect on the rate of absorption of the water flour, it noted that there is an increase in the proportion of absorption of flour to increase water storage period of flour. Despite the increase between each storage period and the subsequent period it were not always moral, but that the average ratio of the absorption of flour has increased in significance when increasing the storage period from one day to ten days, and when increasing the storage period to 30 days was also increased significantly, has The percentage of the calculated increase in the absorption of the precise impact of water storage period compared to 7% for the storage for

a day. On the other hand, the results he found [14]. indicate that the properties of flour stored for a long period of change and cause the low absorption of flour water attributed the reason for this to the effect of acids of the flour is saturated during storage, which can reduce the absorption water.

Affected overlap temperatures with periods storage significant effect on the proportion of flour to absorb water as referred to in the results in the Table 3, which shows that when storage under 27.5°C degree temperature was the highest absorption at longer storage period of 30 days, where the percentage of absorbency of 57.8% to 60.8% and that margin percentage calculated increase of almost 5%, as results showed that when the storage of flour under the degree 37.5°C temperature was water absorption ratio when storage for a day 58.93% but it rose to 61.53% at Storage for 20 days, while the highest absorption in the flour at the Storage 37.5°C degree heat and a period of thirty days storage of 61.84%, which gave an increase in the absorption rate, when compared storage degree 27.5°C and storage for a day, calculated as a percentage estimated at 6.9%. And possibly due to the low percentage of moisture of the flour referred to in the Table 3 where whenever a low of flour in the proportion of humidity whenever absorbed water high [15]. and to the high proportion of gluten wet as he pointed out by [16]. On the other hand, these results may not be consistent with those indicated by the [17]. that when wheat flour is stored moisture 11.5% on the degree of 22.5°C heat, and for a period of 32 weeks found that the impact on the absorption of flour to water and its properties rheological was limited.

**Table 3. The effect of storage temperature and termon the rate absorption off lour(%)**

	B1	B2	B3	B4	B5	Means	LSD, 5%	
A1	57.80	58.10	59.40	60.20	60.80	59.26	1.09	
A2	58.93	59.62	60.76	61.53	61.84	60.54		
Means	58.37	58.86	60.08	60.87	61.32	2.22		
LSD, 5%	1.31							

\*A<sub>1</sub> : 27.5 ° :A<sub>2</sub> :37.5 ° :B<sub>1</sub>:day ·B<sub>2</sub> :days 3 · B<sub>3</sub> :days 10 ·B<sub>4</sub> :days 20 ·B<sub>5</sub>days 30.

The dough development time:

It is defined as the time required for the curve to reach the highest peak, and determined References [18] in 2.3 minutes average. Because whenever a period of evolution rose increased the ability of the dough to form a strong network gluten her ability to hold gases during fermentation baking industry [19]. Some studies suggest the results [20]., that the strong flour needs to be a longer development time compared to a time of weak development of the flour, and the low development time give the dough baking quality is poor [21]. There are significant effect degrees Storage temperature under study on the dough development time as indicated in the Table 4, which notes that there are significant increase in the time of evolution (maturity) at Storage 37.5°C on the degree of

heat compared to what it is at the Storage 27.5°C. Storage and periods studied morally did not affect the dough development time as referred to in the data recorded in the same table. And generally averages the values of this trait ranged according to the storage periods between 1.73 to 1.93 minutes. These results are consistent with those indicated by [14]. that the properties of the flour changed during the process of ripening and started chemical changes after 4-5 days after milling and lasted for 3 weeks almost, has concluded that the period of ripening task careful to find the ideal bread despite that this period were affected by several factors, including the duration of ripening and characteristics of the flour and the circumstances of the storage.

**Table 4. the effect of storage temperature and his termon the dough development time(min)**

	B1	B2	B3	B4	B5	Means	LSD, 5%	
A1	1.60	1.76	1.77	1.80	1.80	1.75	0.13	
A2	2.00	1.77	2.10	1.97	1.67	1.90		
Means	1.80	1.77	1.93	1.88	1.73	n.s		
LSD, 5%	n.s							

\*A<sub>1</sub> : 27.5 ° :A<sub>2</sub> :37.5 ° :B<sub>1</sub>:day ·B<sub>2</sub> :days 3 · B<sub>3</sub> :days 10 ·B<sub>4</sub> :days 20 ·B<sub>5</sub>days 30.

The results of the same table that the effect of overlap between the storage temperature and epochs did not reach the level of significance, as it is noticed that when storage under 27.5° degree of heat there was a slight rise in the values of this capacity during periods of storage. As at storage temperature under 37.5°C there was a marked increase inequality and shortage, and possibly due to the effect of heat on the installation gluten flour during periods of storage, and is indicated by the [8]. that gluten is responsible for the time needed to make the process of kneading the dough and the emergence of the appropriate degree.

The stability of flour paste:

The stability of the dough is the time interval over which keeps the dough textures line 500 Brabandar units. It is very important for the type of fermentation and mechanical effort that exposed the dough, and linked to the extent of dough stability or retaining Blench ideal under different mixing conditions, where this period vary from flour to another [22].

The table shows the results (5) that the effect of temperatures under study on the stability of the dough was significant, with an average increased stability of the dough when wheat flour storage under 37.5°C degree heat to 4.45 minutes while the period of stability was 2:23 minutes at the exact storage temperature at 27.5 degrees °C and that percentage difference between the calculated amount of almost 50%. The results of the

researchers [23] to increase the period of stability and improvement in the US wheat flour stored for 15 months at a temperature between 4°C and 25°C and relative humidity 28% and 73%.

Regarding the impact of periods of storage in this manner, the results showed that there was a significant decrease in the stability of the dough when increasing the storage period from one day to 10 days, but that when you increase the storage period up to 30 days, the rise occurring in this capacity compared to the storage for 10 days, and that did not reach the level of significance. It is evident from the data in the Table 5 that overlap with degrees Storage temperature storage periods under study had a significant impact on the stability of the dough period, where the stability of the dough ranged between 1.97 and 6.80 minutes. And noted stability values fluctuate when storage under 37.5°m degree heat, it was characterized by high values compared to those values when the degree Storage 27.5° C. The consistent results of this study with as pointed out by [14]. that the wheat flour is the processor inventory for a year on the degree of 30° C heat and 40° C and milled by extracting 75% have been affected by his qualities rheological The farinograph examination flour stored indicators in temperature 30° C caused a change in the rheological properties of dough, on the other hand pointed out that the degree 40° C Storage temperature resulted in an increase in stability.

Table 5. The effect of storage temperature and the stability of his term (minutes)

	B1	B2	B3	B4	B5	Means	LSD, 5%
A1	2.77	1.97	2.07	2.10	2.27	2.23	1.46
A2	4.27	4.47	2.90	6.80	3.80	4.45	
Means	3.52	3.22	2.48	4.45	3.03	1.97	
LSD, 5%	1.08						

\*A<sub>1</sub> : 27.5 ° :A<sub>2</sub> :37.5 ° :B<sub>1</sub>:day •B<sub>2</sub> :days 3 • B<sub>3</sub> :days 10 •B<sub>4</sub> :days 20 •B<sub>5</sub>days 30.

The impact of degrees Storage temperature and epochs on extensograph properties:

Extensograph characteristics strength of flour paste (energy):

Describes the results in Table 6 no significant impact on the strength of the impact of the dough storage temperature where the exact storage under temperature heat storage 37.5°m to give high value (100.67cm<sup>2</sup> relatively) compared with storage under 27.5°m degree heat (78.93cm<sup>2</sup>). For the impact of storage periods on the strength of the dough, the results showed the Table 6 that there is a significant effect for a period of 30 days of storage compared to the rest periods studied Storage, which did not differ significantly from each other. And explains the increased strength of the dough with the increase in the storage period is referred to [8]. the exact storage (ageing) lead to raise the percentage of free sulphur groups that make good flour for baking. Also,

notes the existence of a significant effect on the strength of the dough to overlap temperatures with periods of storage under study, and may accordingly from 76 to 2 to 121 cm<sup>2</sup>, calculated as a percentage increase of 59.2% are ranged. And it has been observed slightly higher (not significant) for this trait when increasing the storage period under the degree Storage 37.5° m from one day to 10 days, and then rise in morale. The results of this study are consistent with what indicated by [8] that the wheat flour is inventory wizard for a year on the degree of heat 20°, 30° and 40°m ground and extraction by 75% have been affected by his qualities as the rheological examination Alfviograf flour stored indicators 30°m degree in temperature caused a change in the rheological properties of dough, on the other hand Noting there are storage in 40°m degree heat resulted in the largest increase in the strength of the dough quoted them by increasing the stability and dough development time.

Table 6. The effect of storage temperature and the termon the energy(cm<sup>2</sup>)

	B1	B2	B3	B4	B5	Means	LSD, 5%
A1	80.66	76.00	77.67	80.67	79.67	78.93	9.55
A2	79.67	92.67	91.67	89.00	121.00	100.66	
Means	80.17	84.33	84.67	84.83	100.33	15.32	
LSD, 5%	7.87						

\*A<sub>1</sub> : 27.5 ° :A<sub>2</sub> :37.5 ° :B<sub>1</sub>:day •B<sub>2</sub> :days 3 • B<sub>3</sub> :days 10 •B<sub>4</sub> :days 20 •B<sub>5</sub>days 30.

Extensibility of Dough Results

Table 7 shows that there is no significant effect of the studied degrees Storage temperature on the dough extensibility, and this means that the temperature is under study for the storage of flour do not play influential role on the extensibility of the dough. Results in Table 7 to the existence of significant differences in the impact of extensibility dough flour storage periods under study, noting the increase in the average values of extensibility flour paste stored for 3 days was significantly compared to the Storage day. but it resumed decline to 149.8 mm in the flour store dough for 10 days and continued to decline the progress of the storage period until it reached 134.3 mm in

the flour paste stored for 30 days, where we find that the proportion of the calculated decline estimated at about 15.2, 10.4 and 6.5%, compared to periods Storage 30.20 and 10 days respectively. Had the effect of overlap between the storage temperature and epochs moral impact on the extensibility dough recipe (Table 7), the study data showed that there is a reduction of this capacity increase storage period from 3 days to 30 days, regardless of storage temperature. While the sharp rise observed and non-moral every flour after milling for a period of 3 days. And generally extensibility paste values to the impact of this interference from 132 to 0 to 159.7 mm ranged.

Table 7. The effect of storage temperature and his termon the dough extensibility (mm)

	B1	B2	B3	B4	B5	Means	LSD, 5%
A1	146.0	157.0	157.0	141.7	136.7	146.27	n.s
A2	150.0	159.7	142.7	145.7	132.0	146.00	
Means	148.00	158.30	149.83	143.67	134.30	12.15	
LSD, 5%	6.13						

\*A<sub>1</sub> : 27.5 ° :A<sub>2</sub> :37.5 ° :B<sub>1</sub>:day •B<sub>2</sub> :days 3 • B<sub>3</sub> :days 10 •B<sub>4</sub> :days 20 •B<sub>5</sub>:days 30•.

Resistance of the rubber dough (flexibility):

The results show in the Table 8 that the storage temperature has affected a significant effect on the recipe resistance paste stretchable, resistance has increased from 318 to 5 Unit Brabandar in flour stored paste under the degree 27.5°m temperature to 394.9 Brabandar unit in flour stored paste under temperature 37.5 heat °m, and calculated as a percentage increase up to 24% compared to with storage 27.5° m. These results confirm that the degree of the exact storage temperature play a major role in this capacity that has increased very significantly increased high temperature, was [23] has pointed out in the study that high values of flexibility is required in the types of pastry flour and private biscuits, and in order to hinder the process of individual dough, also it pointed out that wheat has a strong flexibility of up to 445 Brabandar unit.

Results indicated appear in the same table to the exact storage period influenced significant effect on the recipe

resistance paste stretchable, where fall after a 3-day storage, then rebound but it did not reach the level of morale after 10 days of storage, but to increase storage period to 20 and 30 on the percentage increase calculated moral and reached 36 and 41% sequentially. High resistance recipe stretchable up the exact storage period is probably due to improved properties of the network gluten be caused by peroxides resulting from the oxidation of fatty acids.

As can be seen from the results in the Table 8 that overlap workers degrees Storage temperature and epochs under study had a significant effect on the exact recipe resistance stretchable, values ranged from 280 to 490 Brabandar units and percentage increase amounted to 75%. And it noted that the exact storage temperature under 37.5°m led to high resistance stretchable after storage for 30 days, and a significant difference.

Table 8. The effect of storage temperature and his termon the resistance of the dough extensibility (flexibility) (Brabandar unit)

	B1	B2	B3	B4	B5	Means	LSD, 5%
A1	329.00	280.00	303.70	337.70	342.00	318.47	35.72
A3	349.00	310.00	356.00	469.70	490.00	394.93	
Means	339.00	295.00	329.84	403.67	416.00	89.12	
LSD, 5%	43.33						

\*A<sub>1</sub> : 27.5 ° :A<sub>2</sub> :37.5 ° :B<sub>1</sub>:day •B<sub>2</sub> :days 3 • B<sub>3</sub> :days 10 •B<sub>4</sub> :days 20 •B<sub>5</sub>:days 30•.

The relative number

Pointed out some references [15]. that the exact, which has the relative number less than 1 is better for the manufacture of biscuits, while the relative number 0.32 ± 2 and the values of relatively high extensibility (about 195 mm) expresses the precise strong favor for baking without improver.

Results of the study appear in the Table 9 to the extent that the exact storage temperature significant effect on the relative number of the flour paste, has led exact storage under 27.5° degrees Celsius to reduce the average number relative to 2.19 compared with storage temperatures 37.5°m (2.77), calculated by the low amount of 38.5%. These results confirm that the high degree exact storage temperature increases the relative number and thus

increase the validity of flour for baking, has pointed out [24] that the relative number of strong varieties of wheat is 2.4. The results indicated in the Table 9 that for a period of flour store significant effect on the value of the relative figure, these values ranged from 1 to 92 to 3.13 in each of the storage period 3 days and 30 days respectively, which notes the decline of moral relative to the number when you lift the storage period of the day to 3 days, then come back at the moral elevation increase storage period. For the impact of interference between temperatures and periods of storage flour (Table 9), the results indicated the presence of differences were not significant at the exact storage on the degree of 27.5°m, as observed high relative number increase the storage period for a period of 30 days, but the relative figure dropped in flour paste buffer for 3

days and 10 days than it is at the beginning of the storage period. The Storage on the degree of 37.5° of the period of rest of the flour of not less than 3 days can improve the qualities of the dough.

**Table 9. The effect of storage temperature and his term on the ratio number%**

	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	B <sub>4</sub>	B <sub>5</sub>	Means	LSD, 5%
A <sub>1</sub>	2.27	1.87	1.93	2.40	2.50	2.19	0.214
A <sub>2</sub>	2.37	1.97	2.50	3.23	3.77	2.77	
Means	2.32	1.92	2.22	2.82	3.13	0.62	
LSD, 5%	0.29						

\*A<sub>1</sub> : 27.5° : A<sub>2</sub> : 37.5° : B<sub>1</sub> : day : B<sub>2</sub> : days 3 : B<sub>3</sub> : days 10 : B<sub>4</sub> : days 20 : B<sub>5</sub> : days 30.

### 3. Conclusions

-Storage flour under degrees of temperature between 27.5 - 37.5 ± 0.5 C and for a period of from 20-30 days gave high values of water absorption of flour ratio, compared to the fresh flour (1-3 days of milling).

- Careful storage at a temperature in the range of 37.5 ± 0.5 ° C, and for a period of 20 days has led to the lifting of the stability of the dough by 37%, compared to the fresh flour.

- Might get an extensibility (compared to the fresh) for fresh flour paste through careful storage for a period of thirty days, and under conditions of temperatures between 27.5 - 37.5 ± 0.5 Celsius.

- The careful storage after grinding under conditions of temperature of 37.5 ± 0.5 C and for a period of 20-30 days to the significant increase in flexibility compared to fresh flour.

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