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Study of Physicochemical Properties of bottled and circulated drinking water in Ajdabiya, Libya

*Hameda Abde - Wanis Abdel Razek[1]

[1]Department of Zoology, College of Science - Ajdabiya University

*Email: alihameda590@gmail.com

Abstract:

This study was conducted in February 2024 to evaluate the bottled drinking water circulating in the markets of Ajdabiya city for some chemical and physical aspects and the extent of its compliance with the Libyan standard specification and the World Health Specification. The study was conducted by selecting seven samples of bottled drinking water circulating in the city markets, which were Sultan water, eNO, Aquafina, Dijlah, Al-Naba, Al-Ain, and Al-Jazeera. Tests included determining the concentration pH, TDS, sodium Na^{+}, potassium K^{-}, magnesium Mg^{+2}, calcium Ca^{+2}, chloride Cl^{-}, and bicarbonate HCO^{-3}.

The test results for the study samples showed that the concentration of the pH in the study results gave values ranging between (5.8-6.8) and the lowest value was for the waters of (Al-Jazeera, eNO, Tigris and Al-Ain), which do not conform to the Libyan standard specification and the international specification. The test results also showed that the concentration of total dissolved salts ranged between (21.8-115.44) and the lowest value was in the waters of (Al-Sultan, eNO, Tigris and Al-Naba), which do not conform to the Libyan standard and the international specification. The water samples of (Aquafina and Al- Ain) gave concentration results that conform to the Libyan and international specifications. The results of chloride concentration values ranged between (27.8-0.6), calcium concentration results ranged between (5.60-0.01), magnesium concentration results ranged between (12.15-0.01), bicarbonate concentration results ranged between (36.6-0.01), and sodium concentration results ranged between (2.01-0.3) In bottled drinking water, it did not exceed the permissible limits of the Libyan standard specification and the World Health Specification, but it gave values very low than what is recommended in the two specifications, and this negatively affects public health.

Keywords: Ajdabiya, bottled drinking water, physicochemical Properties, Libyan standard, Libya.

The bottled drinking water industry has spread widely in light of the increasing demand for bottled water (Al-Shaib, 2019) due to the spread of pollutants that reach the water in different ways and cause many health problems. In our current era, most water sources have been polluted from oceans, seas, rivers and groundwater (Abu Gelled, 2022).

For reasons related to the quality of drinking water and its availability, which led to an increase in the number of bottled water companies and desalination plants, and thus the emergence of many brands and their spread in local markets, without taking into account their compliance with Libyan and international standards for bottled drinking water and the extent of commitment to chemical and physical properties. Therefore, monitoring water quality is one of the most important factors that help raise the level of public health. This is done by continuously investigating the conditions of water(almaemuriu,2017) (Zahid,2002)

I. Study objectives

This study aims to evaluate the quality of seven types of bottled drinking water that
are most commonly used in the markets of Ajdabiya city The evaluation included the following:

1.Study of the physical and chemical properties of selected drinking water samples.

2.Comparing the results with the Libyan standard specification and the World
Health Organization specification WHO.

II. MATERIALS AND METHODS

The study was conducted in February 2024 Some physical and chemical properties of 7 samples of bottled drinking water circulated locally within the city of Ajdabiya were evaluated. The species were represented in the waters of the Sultan, eNo, Aquafina, Dajla, Al-Naba, Al-Ain, and Al-Jazeera.

The size of the containers was (500) ml, and it was taken into account that the selected packages were sealed and free of defects, and they were transferred to the laboratory
for the purpose of conducting analyses on the water samples selected for the study.

Shows the local water types that were studied

Table No. (1)

Source: laboratory test result.

The test was conducted on the water samples selected in the study at the Libyan Advanced Centre for Chemical Analysis – Tripoli, where the concentration of pH, Total dissolved salts TDC and bicarbonate HCO^{-3} was estimated, the Concentrations of chloride Cl^{-}, Calcium Ca^{+2}, magnesium Mg^{+2}, sodium Na^{+} and potassium K^{+} were measured.

Sample number	Species	Capacity	Origin
1	Sultan	500ml	Tripoli-Libya
2	Eno	500ml	Ghanima-Libya
3	Aquafina	500ml	Tripoli-Libya
4	Dajla	500ml	Tripoli-Libya
5	Anabe	500ml	Tripoli-Libya
6	Aleayin	500ml	Benghazi-Libya
7	Algazira	6000ml	Ajdabiya-Libya

The specification adopted in the study was represented in Table (2)
The Libyan Standard Specifications for Bottled Drinking Water for the year 2008 issued by the National Center for Standards and Metrology has been used as local specifications (Libya, 2008).
The World Health Organization (WHO) specifications are an international specification (Fadel, 2010), and Table No. (2)
shows the limits of the study variables according to the two specifications and compares them with the results of testing the studied samples.
Table No. (2) shows the limits of the concentrations of the variables in the study according to Libyan and international specifications.

Variable	Libyan standard	World Health Organization
PH	6.5 – 8.5	6,5 -8.5
TDS	500	500- 1000
HCO_3	150	200
Cl^-	150	200 – 600
Ca^{++}	-	30 – 200
Mg^+	-	10 – 50
K^+	12	12
Na^-	100	200 – 500

All parameter Concentration Valus are Calculated in mg /L except pH
Source: laboratory test result.

Devices and materials used in the study

The pH was estimated by a pH meter at room temperature, and the total dissolved solids (TDS) were estimated by a multiline-meter (AOAC, 2005).
Sodium and potassium were determined by flame photometer, calcium and magnesium were determined by titration. (EDTA) (Ethylene diamine tetra acetic acid)
Bicarbonate concentration was determined by titration with sulfuric acid and chloride was determined by titration with a standard solution of silver nitrate in the presence of potassium chromate indicator. All tests were performed according to standard methods (APHA, 2005).

III. RESULT AND DISCUSSION

All study sample were examined and compared with the Libyan standard and the WHO standard.
Table No. (3) shows the results of laboratory tests of bottled drinking water for study samples in Ajdabiya city.

V	S1	S2	S3	S4	S5	S6	S7
PH	6.89	6.39	6.50	6.44	6.51	6.3	5.8
TDS	74.75	96.33	115.44	85.28	97.63	102.77	21.78
HCO_3	24.4	30.5	12.2	42.7	36.6	36.6	0.01
Cl^-	21.4	27	0.6	11.1	20.9	27.8	1.3
Ca^+	2.00	5.6	4.004	4.8	4	2.4	0.01
Mg^+	2.188	1.94	12.152	1.457	2.433	2.916	0.01
K^+	0.3	0.6	0.77	0.86	2.01	0.5	0.38
Na^-	26.15	24.41	0.39	26.52	30.34	36.44	0.01

Source: laboratory test result.

A. Estimation of pH

Estimation of pH the study according to Libyan and international specifications Figure (1) shows the results of the tests of the PH values of the study samples, which range between (5.8 and 6.8), where the lowest value of the samples was water (Al-Jazeera, eNo, Dajla, Al-Ain), which is less than the minimum of the Libyan and international standard, and therefore the results of PH gave a low pH value due to the lack of salts present in them (Shalouf , 2018). There are several other causes that affect the pH, such as temperature. When the temperature rises above 25C, there is a decrease in the pH of water by 0.45 (WHO, 2004) The pH changes significantly during water treatment processes. The chlorination process reduces the concentration of the pH, (Ramadan,2013). The pH also affects various processes in water treatment that contribute to removing germs from water. It can be said that it has an indirect impact on public health (Al-Khair ,2005) When the pH decreases, it affects the corrosion of toxic metals such as lead metal. There is no direct relationship between the pH of drinking water and human health, but it has an indirect impact on public health, although the relationship concerns multiple aspects of water quality (Khalil, 2003) The samples (Sultan, Aquafina, Al-Nabaa) had their results within the permissible limits of the Libyan and international standard.

Using Excel software to compare the results of laboratory tests

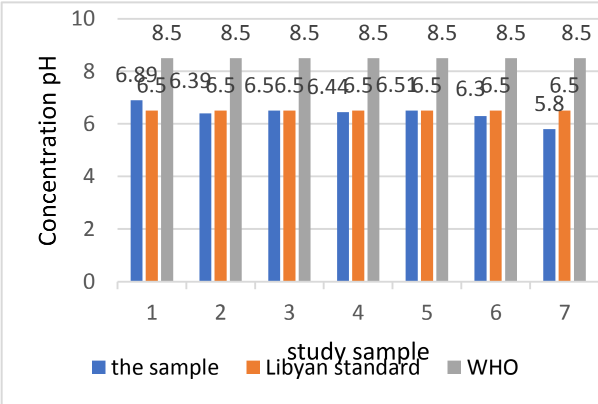
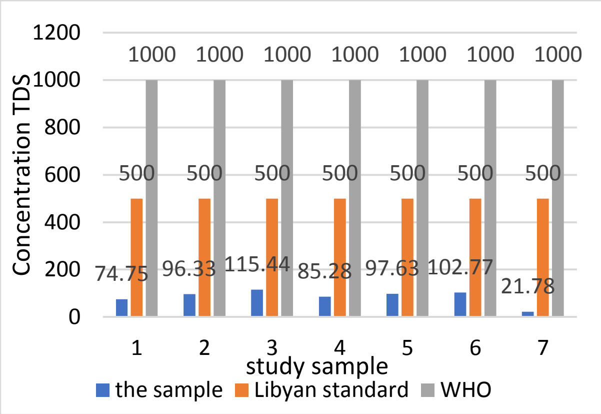


Figure (1) Comparison of the pH concentration of the study samples with the Libyan and WHO standards.

B. Total dissolved salts TDS

Figure (2) shows the results of the tests of the study samples of total dissolved salts, which ranged between (21.82 and 115.44), which shows that the results of the water (Sultan, eNO, Dajla, Al Ain, Al Jazeera) were under the minimum Libyan standard, and because of technical factors related to the quality of treatment and desalination processes and according to the product option and the Concentration of salts in the source of bottled water in the laboratories, which works to reduce the concentration of total dissolved salts (Fisher, 2008) to low levels that may be harmful to public health (Abu-Gelled, 2022), as some studies have shown that the salts dissolved in drinking water can have health effects, as well as water with a low level of dissolved salts that is undesirable to drink (Khalil , 2003) , as the body needs these salts and reliance on these water, which over time may lead to health complications as people who eat them are more susceptible to kidney disease (Abubakr et al .,2024) .

The results of the samples of (Aquafina, Al Ain) water also show that it falls within the limits of the Libyan and international standard (WHO,1997).



Using Excel software to compare the results of laboratory tests

Figure (2) Comparison of the total dissolved salts concentration of the study samples with the Libyan and WHO standards

C. Bicarbonate HC0 $^{-3}$

Figure (3) shows the results of the samples of bottled drinking water. It was found that the values of the samples were between (42.7 and0.01) mg/L. The lowest Concentration of bicarbonate was 0.01 in the waters of Al-Jazeera, and the highest Concentration of bicarbonate was 42.2 in the Tigris water. All the samples did not exceed the permissible limit in the Libyan and international standard, but they gave low values that reached (0.01), thus moving away from the permissible concentration of the Libyan and international standard. This is consistent with what Asma Abdel Hamid reached in his study (Balk, 2019), as the bicarbonate ion is the alkaline component of most water sources and is usually 5-500 mg/L in the form of calcium bicarbonate due to the dissolution of carbon dioxide-generating bacteria from carbon-containing minerals (Al-Nagawi, 2000).

Using Excel software to compare the results of laboratory tests

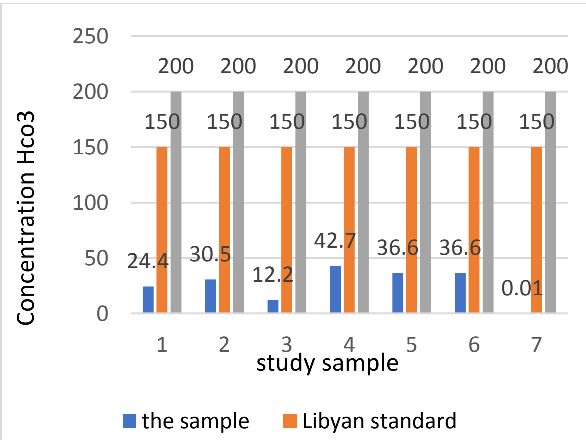


Figure (3) Comparison of the bicarbonate concentration of the study samples with the Libyan and WHO standards.

D. Chlorides Cl

The results, as shown in Figure (4), showed that the Concentrations of chlorides ranged between (27.8-0.6), which gave the Concentrations of all samples values less than the permissible limit in the Libyan standard and the international standard (WHO, 1997) (Libya, 2008) , where the decrease in chloride Concentration values in drinking water leads to a decrease in pressure in the body (Qabasa et al., 2020) , and the concentration of chloride ion is related to the concentration of sodium in water (Al-Sarawi, 2007).

Using Excel software to compare the results of laboratory tests

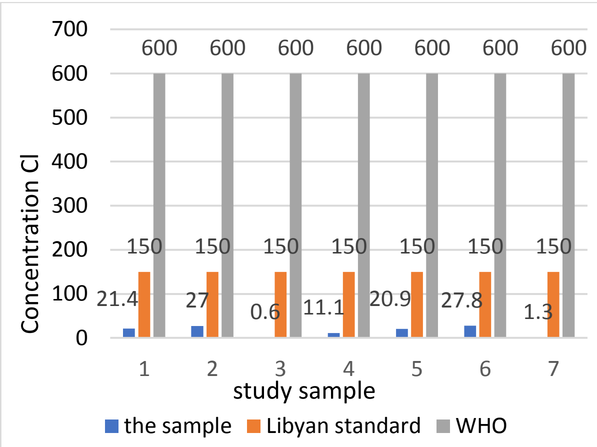


Figure (4) Comparison of the chloride Concentration of the study samples with the Libyan and WHO standards

E.Sodium Na^+

The results, as shown in Figure (5), showed that sodium Concentrations ranged between (36.44 and 0.39), where the results of the Concentrations of the samples studied gave values less than the limit allowed by the Libyan standard and the World Health Organization (WHO, 1997).

Using Excel software to compare the results of laboratory tests

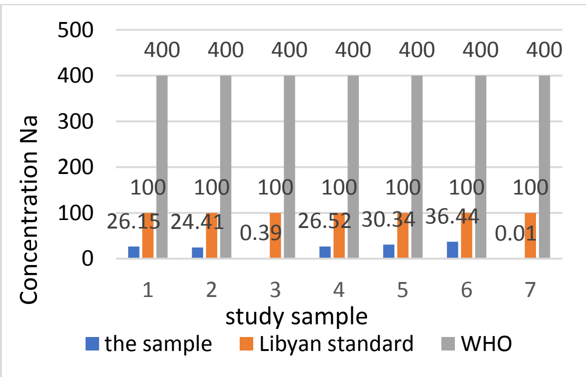


Figure (5) Comparison of the sodium Concentration of the samples with the Libyan and WHO standards study

F. Potassium K^-

The results, as shown in Figure (6), showed that the values of the Concentrations of water samples ranged between (2.01-0.3) compared to the Libyan standard, we find that all samples did not exceed the allowed values in the Libyan standard, and this is consistent with what Intesar Muhammad reached (Abu Gelled, 2022).

The European group of countries has also determined the Concentration of potassium in drinking water 10mg/L (CHAPMAN, 1996), so the values of the Concentrations of the samples are very low, and potassium shares with sodium in regulating the osmotic pressure in the body, and potassium performs special tasks in the delivery of nerve impulses and its decline causes an imbalance in public health (Shalouf, 2018).

Using Excel software to compare the results of laboratory tests

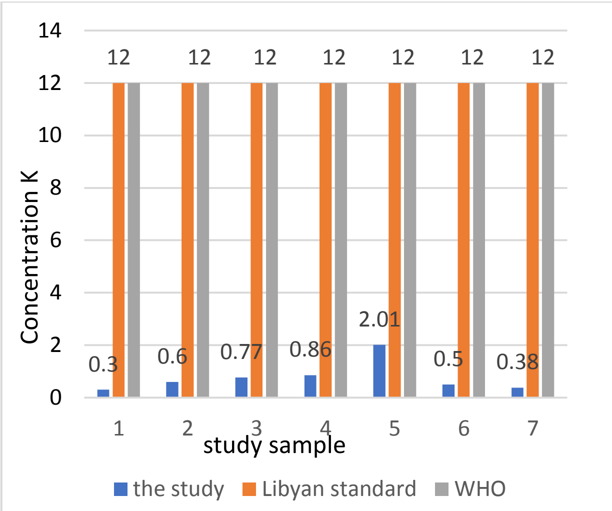
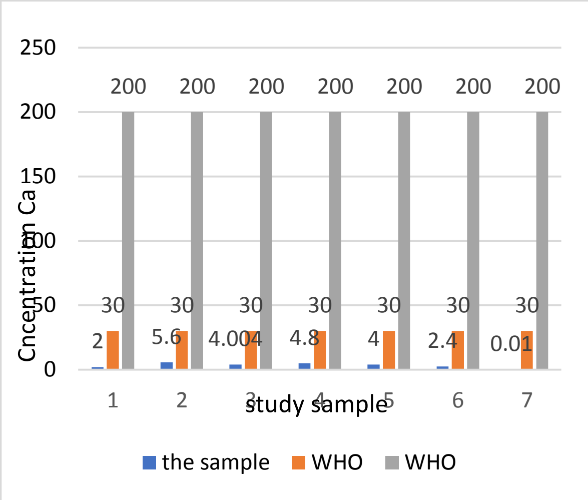


Figure (6) Comparison of the potassium Concentration of the study samples with the Libyan and WHO standards.

G. Calcium Ca^{+2}

The results showed, as in Figure (7), that the values of Calcium Concentrations in water for the study samples range between (5.60-0.01), which is much lower than the Concentrations allowed in the World Health Standard (Balk, 2019) while the Libyan standard specifications did not specify values for the Concentration of calcium, and the Concentration of Calcium in fresh water reaches less than 10 mg/L and about 75mg/L in very salty water (Abbasi ,2004) and that the lack of Calcium Concentration in water leads to the occurrence of rickets disease and its softening in addition to the dysfunction of normal blood clotting (Awaida, 2004).

Using Excel soft ware to compare the results of laboratory tests



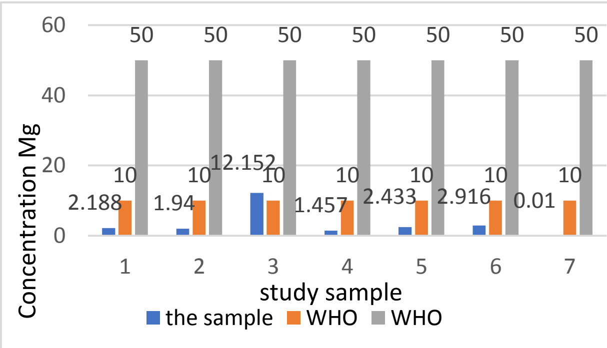


Figure (7) Comparison of the calcium concentration of the study samples with the World Health standard.

H. Magnesium Mg^{+2}

The results, as shown in Figure (8), showed that the Concentrations of magnesium in the study samples gave results ranging between (0.01 and 12.152). By comparing them with the standard for global health, it was found that the values of the Concentrations of the study samples are much lower than the global standard except for the sample value (12.152) Aquafina water, which falls within the global standard limits (WHO, 1997), while the Libyan standard did not specify the Concentration of magnesium in bottled water. Magnesium plays an important role in enzymatic reactions, protein building, nucleic acids, nervous reaction and muscle contraction (Abed, 2007). Therefore, the increase in the Concentration of magnesium affects the intestine. The decrease in its Concentration affects the construction of protein and nucleic acids.

Using Excel soft ware to compare the results of laboratory tests

Figure (8) Comparison of the magnesium concentration samples with the international standard of the study.

Table No. (3) shows the specification values written on the packaging.

V	S1	S2	S3	S4	S5	S6	S7
PH	6.5 - 7	6.5 - 7.5	6.7	6.5 - 7	6.5 - 7.5	6.5-8	7.0
TDS	500 - 1000	100 - 120	105	100 - 120	10 - 100	100 - 130	147
HCO_3	13	15	13	22.6	24	12	7.0
Na	23	16	3	1.9	26	35-65	27
Ca^{++}	4	2	1	4.2	4	-	3.0
K^{+}	0.6	2	1	0.8	3	12	0.4
Cl^{-}	36	20	1.3	23	20	21	34
Mg^{++}	2	5	20	2.2	3	-	3.0

Source: laboratory test result**.**

The Concentrations of the quality standards mentioned on the package were compared with the results of the tests for the study samples. All the quality standards (Mg^{+2}, Cl^{-}, K^{+}, Ca^{+2}, Na^{+}, HCO^{-3}, TDS, PH) included in the study were mentioned on the packages, except for sample No. 6, for which the Concentration of magnesium Mg^{+2} and the Concentration of Calcium Ca^{+2} was not mentioned. The Concentrations on the packages, most of which were not identical to the results of the tests in the study, except for the result of sample No. (5), were identical to what was written on the package.

IV. Conclusion

1-After Comparing the test results of the study samples with the Libyan standard and the international health standard, it was found that the value of the pH Concentrations was lower than the minimum allowed in the Libyan and international standard WHO.

2-The results showed a decrease in the Concentrations of total dissolved salts (TDS) for water samples (Al-Jazeera, Al-Sultan, eNo, Dajla, Al-Nabaa) from the permissible limit in the specification and the rest of the samples were within the permissible limits in the Libyan standard and the World Health Specification.

3-Concentrations (sodium, potassium, Calcium, magnesium, chloride and bicarbonate) of the results of the study samples and compared to the Libyan standard and the International Health Standard, the results of the samples did not exceed the upper limit of the two specifications but gave very low Concentrations.

V. Recommendations

1. Conducting periodic qualitative tests on bottled drinking water and determining its compliance with the Libyan standard before entering the market.

2. Regulatory follow-up by the competent regulatory authorities (health, environmental, industrial, and commercial) to conform bottled water to the Libyan standard and the international health standard.

3. Requiring water producing companies to establish laboratories to continuously test water to ensure its conformity with the Libyan standard.

4. The results of the values mentioned on the packages showed a clear discrepancy when compared with the results obtained. It is recommended that the regulatory authorities tighten the bottled water stated on the package and that it conforms to the Libyan and international standards.

الملخص

أجريت هذه الدراسة في فبراير 2024 لتقييم مياه الشرب المعبأة والمتداولة في أسواق مدينة اجدابيا لبعض النواحي الكيميائية والفيزيائية ومدى مطابقتها للمواصفة القياسية الليبية ومواصفة الصحة العالمية، حيث أجريت الدراسة باختيار سبع عينات من مياه الشرب المعبأة المتداولة في أسواق المدينة، وتمثلت في مياه السلطان، eNO، كوافينا، دجلة، النبع، العين، الجزيرة.

شملت الاختبارات تحديد تركيز كل من الاس الهيدروجيني pH ، الاملاح الذائبة الكلية TDS ، الصوديوم Na^{+} ، البوتاسيوم K^{+}، الماغنيسيوم Mg^{+2} ، الكالسيوم Ca^{+2} ، الكلوريد Cl^{-} ، والبيكربونات. HCO^{-3} .

حيث أظهرت نتائج الاختبارات لعينات الدراسة ان تركيز الرقم الهيدروجيني في نتائج الدراسة أعطت قيم تراوحت بين (5.8–6.8) وكانت اقل قيمة لمياه (الجزيرة و eNO ودجلة والعين) وهي غير مطابقة للمواصفة القياسية الليبية ومواصفة العالمية ، كما وأظهرت نتائج الاختبارات ان تركيز الاملاح الذائبة الكلية يتراوح بين (21.82–115.44)وكانت اقل قيمة في مياه (السلطان و eNO ودجلة والنبع) وهي غير مطابقة للمواصفة الليبية والمواصفة العالمية وان عينات مياه (كوافينا والعين)أعطت نتائج تراكيز مطابقة للمواصفة الليبية والعالمية ،وقد اظهرت نتائج قيم تراكيز الكلوريد التي تتراوح بين (0.6–27.8) ونتائج تراكيز الكالسيوم التي تتراوح بين (0.01–5.60) ونتائج تراكيز الماغنيسيوم التي تتراوح بين (0.01–12.15) ونتائج تراكيز البيكربونات التي تتراوح بين (0.01–36.6)ونتائج تراكيز الصوديوم التي تتراوح بين (0.3–2.01) في مياه الشرب المعبأة انها لم تتجاوز الحدود المسموح بها للمواصفة القياسية الليبية ومواصفة الصحة العالمية الا انها أعطت قيم منخفضة جدا عن ما موصى به في المواصفتين وهذا يؤثر سلبا على الصحة العامة .

الكلمات المفتاحية: اجدابيا، مياه الشرب المعبأة، الخصائص الفيز وكيميائية، المواصفة الليبية، ليبيا

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