TABLE 1.3 The Arsenic and Heavy Metal Contents in Cockles Obtained From 20 Sites at the Juru and Jejawi Rivers (mg/L)

Location	Cr	As	Cd	Zn	Cu	Pb	Hg
Juru	0.20	2.38	0.82	0.23	0.20	0.13	1.40
Juru	0.17	2.94	0.86	0.23	0.16	0.13	1.45
Juru	0.15	2.53	0.88	0.21	0.24	0.11	1.31
Juru	0.15	2.61	0.92	0.29	0.20	0.13	1.19
Juru	0.15	2.89	0.92	0.23	0.21	0.14	1.46
Juru	0.17	2.58	0.89	0.21	0.20	0.12	1.41
Juru	0.18	2.83	0.88	0.21	0.20	0.12	1.30
Juru	0.18	2.61	0.89	0.20	0.18	0.11	1.28
Juru	0.16	2.64	0.90	0.24	0.18	0.12	1.27
Juru	0.18	2.66	0.89	0.21	0.20	0.12	1.33
Juru	0.18	2.73	0.90	0.19	0.18	0.13	1.33
Juru	0.16	2.57	0.89	0.18	0.17	0.12	1.42
Juru	0.16	2.61	0.84	0.22	0.17	0.12	1.28
Juru	0.17	2.86	0.86	0.25	0.17	0.12	1.27
Juru	0.16	2.60	0.88	0.20	0.18	0.11	1.24
Juru	0.17	2.83	0.91	0.19	0.19	0.12	1.42
Juru	0.16	2.83	0.91	0.23	0.17	0.12	1.31
Juru	0.17	2.62	0.88	0.23	0.16	0.13	1.36
Juru	0.14	2.42	0.90	0.20	0.17	0.11	1.36
Juru	0.18	2.69	0.92	0.19	0.17	0.12	1.24
Jejawi	0.17	2.61	0.85	0.20	0.17	0.12	1.36
Jejawi	0.16	2.90	0.88	0.18	0.21	0.13	1.44
Jejawi	0.15	2.57	0.89	0.22	0.22	0.12	1.41
Jejawi	0.16	2.70	0.84	0.19	0.19	0.14	1.28
Jejawi	0.15	2.77	0.88	0.17	0.20	0.12	1.35
Jejawi	0.19	2.61	0.84	0.19	0.15	0.12	1.41
Jejawi	0.18	2.69	0.88	0.20	0.18	0.11	1.44
Jejawi	0.17	2.75	0.88	0.18	0.23	0.12	1.41
Jejawi	0.17	2.65	0.88	0.22	0.19	0.12	1.36
Jejawi	0.17	2.60	0.82	0.22	0.19	0.12	1.44
Jejawi	0.16	2.70	0.93	0.20	0.20	0.12	1.25
Jejawi	0.16	2.43	0.88	0.20	0.19	0.12	1.44
Jejawi	0.16	2.69	0.93	0.18	0.20	0.12	1.40
Jejawi	0.18	2.82	0.89	0.19	0.18	0.12	1.23
Jejawi	0.15	2.60	0.84	0.20	0.20	0.14	1.29

(*Continued*)

TABLE 1.3 (Continued)

Location	Cr	As	Cd	Zn	Cu	Pb	Hg
Jejawi	0.18	2.88	0.86	0.19	0.17	0.12	1.21
Jejawi	0.15	2.90	0.89	0.18	0.17	0.12	1.36
Jejawi	0.17	2.89	0.87	0.20	0.17	0.13	1.32
Jejawi	0.18	2.45	0.79	0.24	0.15	0.14	1.50
Jejawi	0.15	2.61	0.85	0.18	0.19	0.11	1.32

fatty acid (PUFA), monounsaturated fatty acid (MUFA), oil color values (lightness (L*) value, redness (a*), and yellowness (b*)), and moisture content (%). The data are given in Table 1.4.

Observe that the data do not provide useful information for making a comparison between different brands based on the selected parameters. The objective of the study was to assess the quality characteristics of tapioca chips regarding their fat oxidation, fat content, fatty acid composition, and moisture and oil color values. Furthermore, the objectives include finding the similarities between different brands based on the selected parameters and finding the source of the differences between these brands. The last goal was to identify the parameters responsible for the distinctions between the brands.

Example 1.4: Antioxidant in dates—Edible parts of date palm (Phoenixdactylifera) fruits (DPF) were sampled and analyzed for their antioxidant activities (AA) using the Trolox equivalent antioxidant capacity (TEAC) method, 2,2'-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) radical cation ($ABTS^{+}$) assays and the ferric reducing/antioxidant power method (FRAP assay). The total flavonoid content (TFC) and total phenolic content (TPC) of the DPF were measured using the aluminum chloride colorimetric and Folin−Ciocalteaumethods, respectively. Four types of soft dates (SD), namely, Jiroft dates, Honey dates, Kabkab dates, and Bam dates, were used; three types of semidry dates (SDD), namely, Piarom dates, Zahedi dates, and Sahroon dates, and one type of dry date (DD) (Kharak dates) were also used. The data are given in Table 1.5.

The main goal of this study was to evaluate the AA of methanolic extracts from eight different types of DPF using the ABTS and FRAP methods. We investigated the similarities between different types of dates to study the relationships between various parameters. The goal was to understand the behavior of each variable in the presence of the other variables. Furthermore, we tested the differences among the selected varieties of dates regarding the antioxidant activities (ABTS and FRAP assay) and antioxidative compounds (flavonoids content and total phenolic). The final objective was to identify the source of the variation in the dates and to detect the effects of each parameter on the degree of differentiation among the same varieties of dates.

1.4 MULTIVARIATE NORMAL DISTRIBUTION

Most of the methods used in statistics for analyzing data are based on the normality assumption; the data are obtained from a normally distributed population. The multivariate normal distribution is an extension of the univariate normal distribution and shares many of its properties.

A brief discussion of the univariate and multivariate normal distributions is provided below.

a. Univariate normal distribution

Suppose Y is a random variable that follows the normal distribution. Then, the univariate normal distribution with mean μ and variance σ^2 is given in (1.1).

$$f(Y) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-(Y-\mu)^2}/2\sigma^2 - \infty < Y < \infty \tag{1.1}$$

It can be said that Y is distributed as $N(\mu, \sigma^2)$.