

Effect of Skin-contact Time and Temperature on Juice and Wine Composition and Wine Quality

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The effect of skin-contact time (4 hours and 15 hours) and temperature (0°C and 20°C for 20 hours) on terpene, phenol and acetamide concentrations in Gewürztraminer juices and wines and on wine quality was investigated. An increase in skin-contact time and temperature generally resulted in increases in terpene, phenol and N-(3-methylbutyl)-acetamide concentrations. Wines produced from juice subjected to low temperature skin-contact were generally of a higher quality than wines produced from free-run juice or juice subjected to skin-contact at elevated temperatures.

Terpenes are important constituents in various grape cultivars. From the literature it is clear that an abundance of terpenes is to be found in the berry skin of certain cultivars (Bayonove, Cordonnier & Ratier, 1974; Cordonnier & Bayonove, 1981; Gunata *et al.*, 1985; Williams *et al.*, 1985; Wilson, Strauss & Williams, 1986). Skin-contact could, therefore, result in the extraction of additional terpenes and lead to an increase in cultivar typical aromas and quality of wines (Versini, Inama & Sartori, 1981; Marais, 1987, 1988). Skin-contact may, however, also result in increases in the concentrations of constituents, such as certain phenolic compounds, which may be detrimental to wine quality (Ramey *et al.*, 1986). Skin-contact time, as well as the temperature at which the treatment is applied, could therefore be critical to the composition and quality of juices and wines.

White cultivar wines, produced in warm wine-producing countries, often lack sufficient and characteristic aromas. Therefore, it is of great importance to study viticultural and oenological aspects which may affect aroma. This paper reports on the effect of skin-contact time and temperature on the concentrations of certain terpenes, phenolic compounds and an acetamide, as well as on the quality of Gewürztraminer wines.

MATERIALS AND METHODS

Vitis vinifera L. cv. Gewürztraminer grapes from three vintages and at different ripening stages were used in this study. In 1985 and 1986 grapes from the Tulbagh region (2255 degree-days), were subjected to skin-contact for 4 hours and 15 hours respectively. In 1987 grapes from the Stellenbosch region (1946 degree-days), were subjected to skin-contact for 20 hours at temperatures of 0°C and 20°C respectively. Wines were sensorially evaluated for terpene-like character and overall quality by a panel of experienced judges. Capillary gas chromatography involved the analyses of terpenes, phenol, 4-vinylguaiacol and N-(3-methylbutyl)-acetamide (Marais, 1986). The wines of the 1987 vin-

tage were also analysed for total phenols. Further details of procedures applied during the harvest, juice treatments, fermentation, sensory evaluations of the wines, gas chromatography, mass-spectrometry and statistical analyses were described previously (Marais, 1987, 1988; Marais & Van Wyk, 1986).

RESULTS AND DISCUSSION

Effect of skin-contact time on terpene concentrations and wine quality:

The effect of skin-contact time on geraniol concentrations which displayed typical terpene concentration changes, is shown in Fig. 1. In all cases, the free-run treatment was considered as the control.

Figure 1A clearly shows that skin-contact resulted in substantial increases in geraniol concentration in Gewürztraminer juices. Within the limits of this experiment, the longer the skin-contact, the higher the geraniol concentration. The sugar concentration varied between 17,9°B and 21,3°B for the 1985 vintage and between 22,0°B and 24,0°B during the 1986 vintage. In spite of these differences, the increases in geraniol concentration were independent of year and grape maturity.

The above-mentioned effect of skin-contact time on geraniol concentration in juices was reflected in the corresponding wines of the 1985 vintage (Fig. 1B). During the 1986 vintage, however, differences between geraniol concentrations in the wines produced from free-run, 4 hours and 15 hours skin-contact treatments were smaller than in the case of the corresponding juices (Fig. 1A). These differences are difficult to explain. The riper grapes of the 1986 vintage, however, could have resulted in juices with significantly different chemical compositions than those of the 1985 vintage. Similarly, differences in skin-contact temperature between the 1985 vintage (between 18°C and 20°C) and the 1986 vintage (10°C) could have had an effect. Furthermore, it is well-known that complex chemical and/

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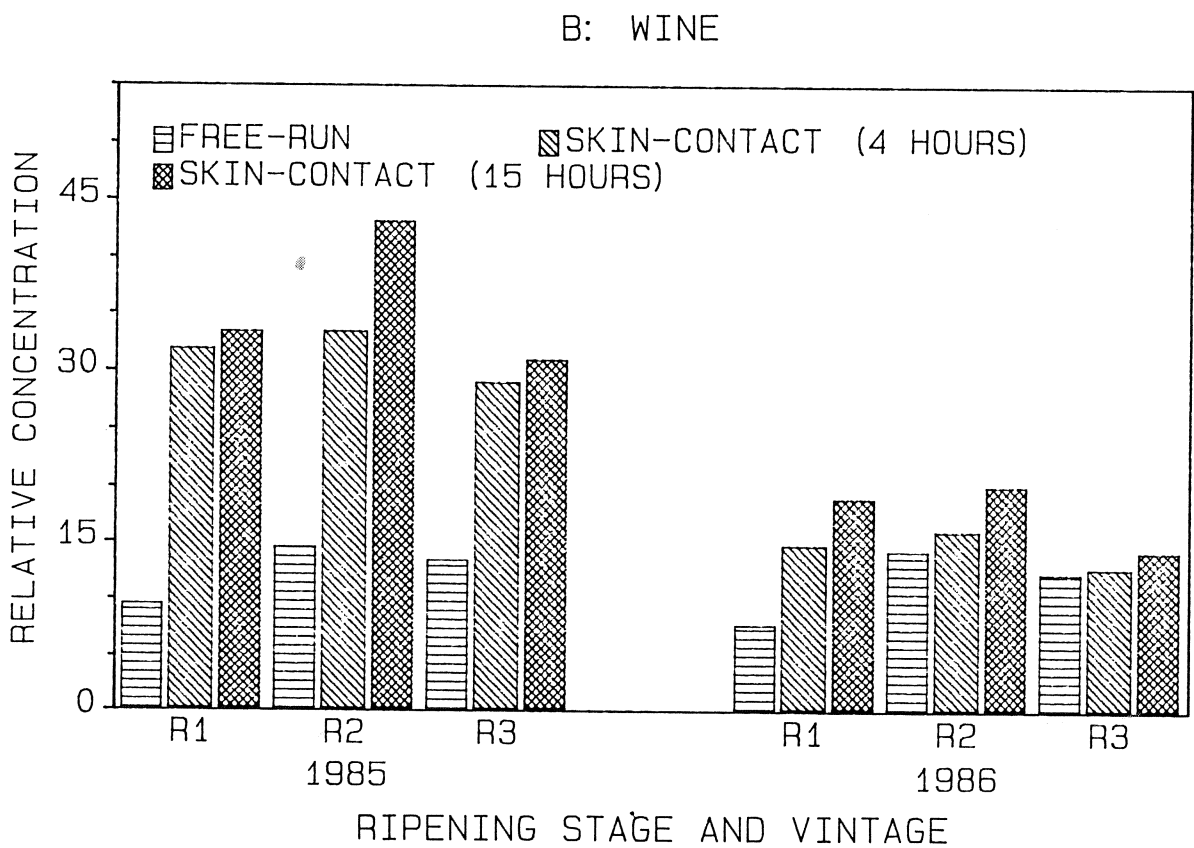
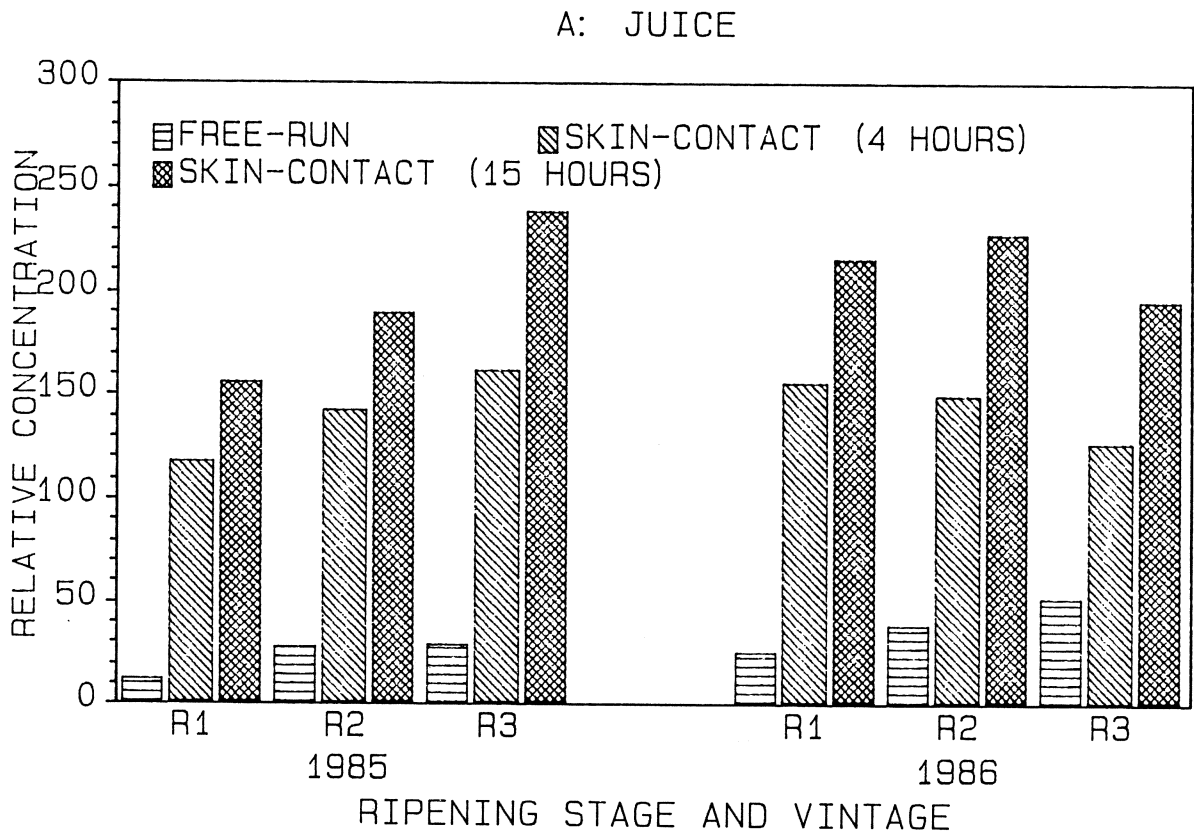


FIG. 1

Effect of skin-contact (4 hours and 15 hours) on geraniol concentration in Gewürztraminer juices (A) and corresponding wines (B) at different ripening stages and from two vintages (1985 vintage: R1 = 17,9°B, R2 = 19,3°B and R3 = 21,3°B; 1986 vintage: R1 = 22,0°B, R2 = 23,0°B and R3 = 24,0°B). Geraniol is expressed as relative concentrations, using a calibration factor of 1.

or enzymatic transformations of terpenes occur during fermentation. All factors mentioned, could have contributed to the above-mentioned phenomenon. Comparisons between juices and their corresponding wines are difficult. Terpene concentrations, which were calculated as relative concentrations, differed between juice and wine which could be ascribed to differences in the degree of terpene extractability between juice and wine media.

Increases in terpene concentrations as a result of skin-contact were also reported by Versini *et al.* (1981) and Marais (1987, 1988). Contradictory findings were reported by Rapp, Güntert & Rieth (1985). Their results on Weisser Riesling wine clearly show that skin-contact for 3 and 24 hours had no effect on terpene concentrations under German climatic conditions. Rapp *et al.* (1985), however, found marked increases in terpene concentrations during fermentation on the skins.

The effect of skin-contact on the intensity of terpene-like character and overall quality of Gewürztraminer wines is illustrated in Fig. 2. No definite pattern was evident and a comparison between sensory evaluation data and geraniol concentrations in Gewürztraminer juices or wines (Fig. 1) is difficult. The changes in terpene-like character and wine quality scores at ripening stages 1 and 3 (Fig. 2, 1986 vintage), however, tend to correspond with the changes in geraniol concentrations in the corresponding juices and wines (Fig. 1).

When the sensory evaluation scores at the other ripening stages (Fig. 2) are viewed, it is evident that in most cases, skin-contact for 4 hours and 15 hours obtained lower scores than the corresponding free-run treatment. The 15 hour skin-contact treatment normally showed the lowest scores. These tendencies, which are contrary to the corresponding tendencies for geraniol concentration (Fig. 1), could possibly be explained by the relatively high skin-contact temperature (between 18°C and 20°C) applied during the 1985 vintage. These wines most probably contained high concentrations of phenol compounds. It is well-known that high phenol concentrations can be responsible for bitter, coarse and astringent after-tastes in wines. Similarly, other compounds which may be extracted from skins during skin-contact at higher temperatures or for longer periods can have a masking effect on the terpene-like character. Unfortunately no analyses were done on phenol compounds in these wines. Du Plessis & De Wet (1968) found an increase in the uptake of tannins and leuco-anthocyanidin by the juice from the skins and seeds with an increase in temperature and contact time. These investigations were done on the cultivars Chenin blanc, White French, Cape Riesling, St Emilion and Clairette blanche. Ramey *et al.* (1986) similarly reported increases in individual and total phenol concentrations in Chardonnay juices and wines with an increase in skin-contact time and temperature. Similar findings were also reported by Ribéreau-Gayon & Glories (1986).

The effect of skin-contact time on terpene concentrations and sensory characteristics was statistically confirmed by combining the relevant data over years and ripening stages. The results for linalool, citronellol, geraniol, terpene-like character and wine quality are shown in Fig. 3.

Figure 3 clearly shows that skin-contact in general resulted in significantly higher ($P \leq 0,10$) terpene concentrations than the free-run treatment in both Gewürztraminer juices and wines. Although the differences in terpene concentrations between 4 hours and 15 hours skin-contact were not significant in all cases, the latter treatment apparently induced higher terpene concentrations. These results were not reflected in the combined sensory characteristic data and differences between juice treatments were not significant in most cases (Fig. 3). The wines produced from the 4 hour skin-contact treatment tended to be of higher quality than those of the other two treatments. As already discussed, skin-contact at increasing temperature and/or longer periods will result in wines with higher phenol concentrations (Ramey *et al.*, 1986). This probably resulted in sensory findings which were contradictory to what could have been expected from the corresponding chemical data. In view of the above-mentioned results, recommendations for ideal skin-contact time/temperature combinations were not possible.

Effect of skin-contact temperature on the concentrations of terpenes, phenol compounds, N-(3-methylbutyl)-acetamide and wine quality:

The effect of skin-contact temperature on the concentrations of linalool, citronellol and geraniol in Gewürztraminer juices and the corresponding wines is illustrated in Fig. 4. Once again, the free-run treatment was considered as the control.

Since it is practically impossible to conduct an experiment, such as this one, more than once during a season, and since too little data are available per treatment, statistical evaluations on the 1987 data were not possible. Nevertheless, Fig. 4A clearly shows that skin-contact resulted in substantial increases in terpene concentrations. These results confirmed those obtained during the 1985 and 1986 vintages. Furthermore, the concentrations of linalool, citronellol and geraniol were in all cases higher as a result of skin-contact at 20°C than for skin-contact at 0°C. These results were independent of the stage at which the grapes were harvested, i.e. between 18,0°B and 23,8°B. Linalool is not of much relevance in the juices specifically, since it occurred in relatively low concentrations (Fig. 4A). Skin-contact also resulted in substantial increases in terpene concentrations in the corresponding wines but some terpene concentrations did not differ much between 0°C and 20°C treatments (Fig. 4B). In some cases the terpene concentrations were higher at 20°C and in others higher at 0°C. Such variations in terpene concentrations could be the result of complex chemical terpene transformations during fermentation. If temperature during skin-contact has no marked effect on individual terpene concentrations, it could be deduced that the typical cultivar character would not be affected either. Other compounds may, however, be extracted from the skins which may affect wine quality differently at different skin-contact temperatures.

In the case of phenol compounds, it is clear that skin-contact, in general, resulted in wines with higher total, as well as individual phenol concentrations than the wines from the free-run control (Fig. 5). An increase in skin-contact temperature from 0°C to 20°C resulted in an increase in total phenol concentration at ripening

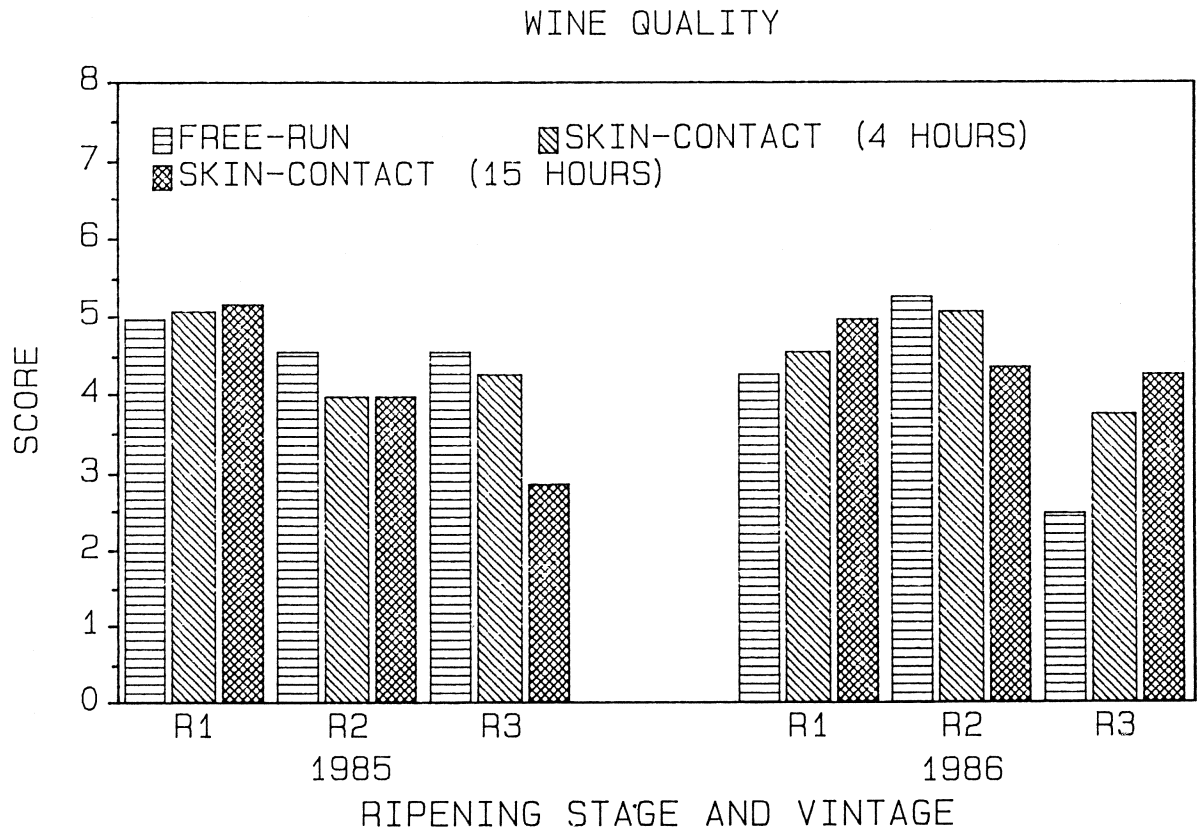
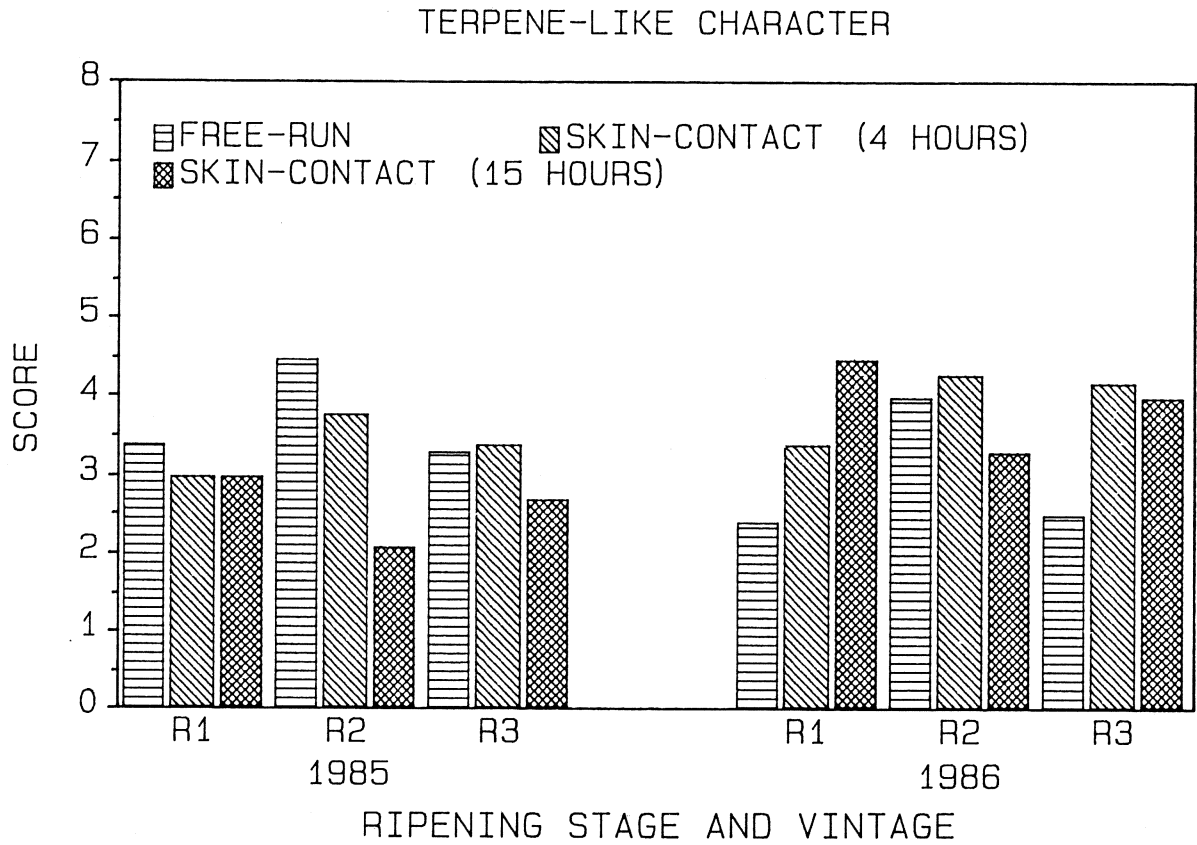


FIG. 2

Effect of skin-contact (4 hours and 15 hours) on terpene-like character (intensity) and overall wine quality of Gewürztraminer wines at different ripening stages and from two vintages (1985 vintage: R1 = 17,9°B, R2 = 19,3°B and R3 = 21,3°B; 1986 vintage: R1 = 22,0°B, R2 = 23,0°B and R3 = 24,0°B).

Effect of skin-contact on wine quality

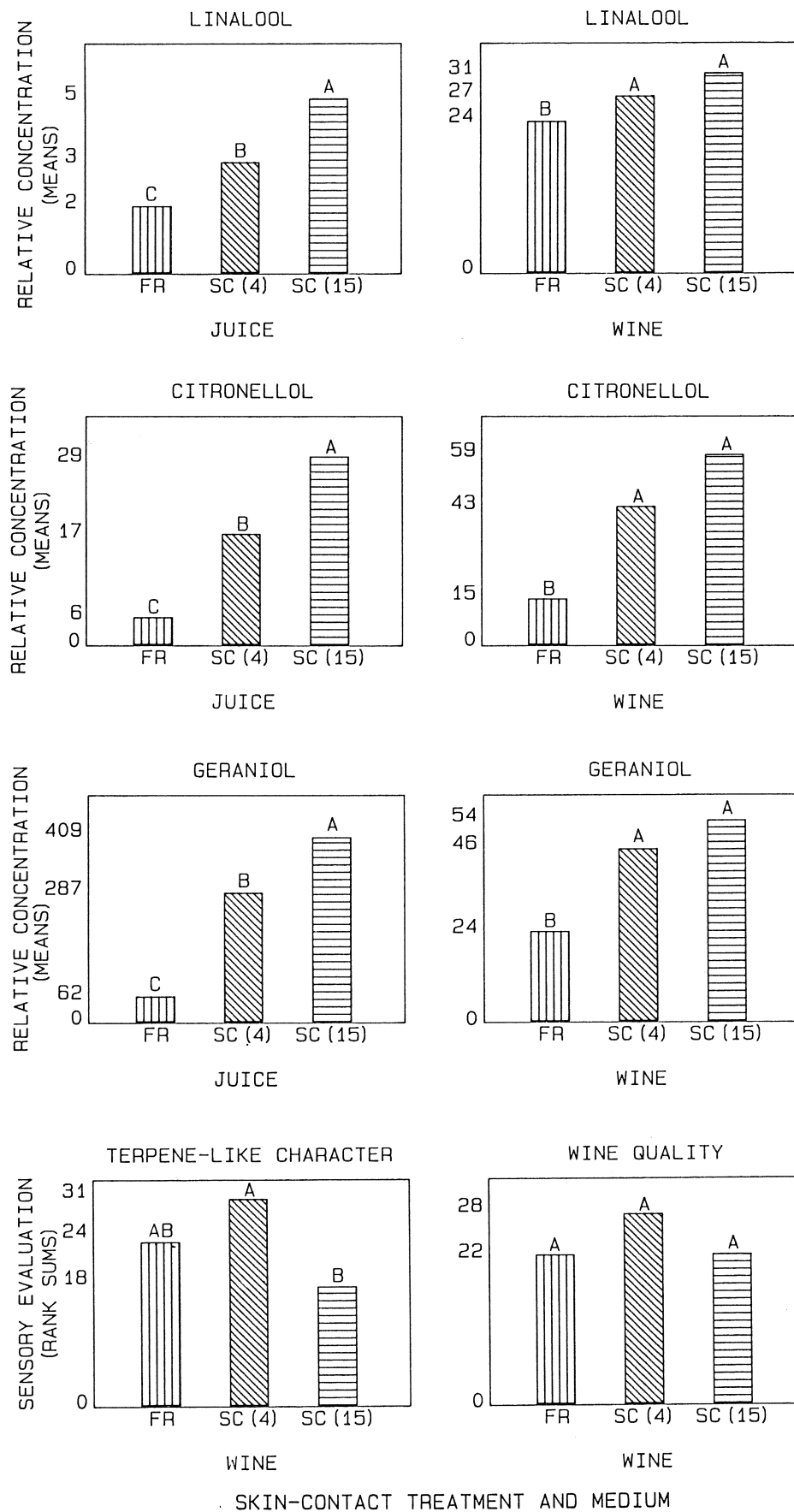
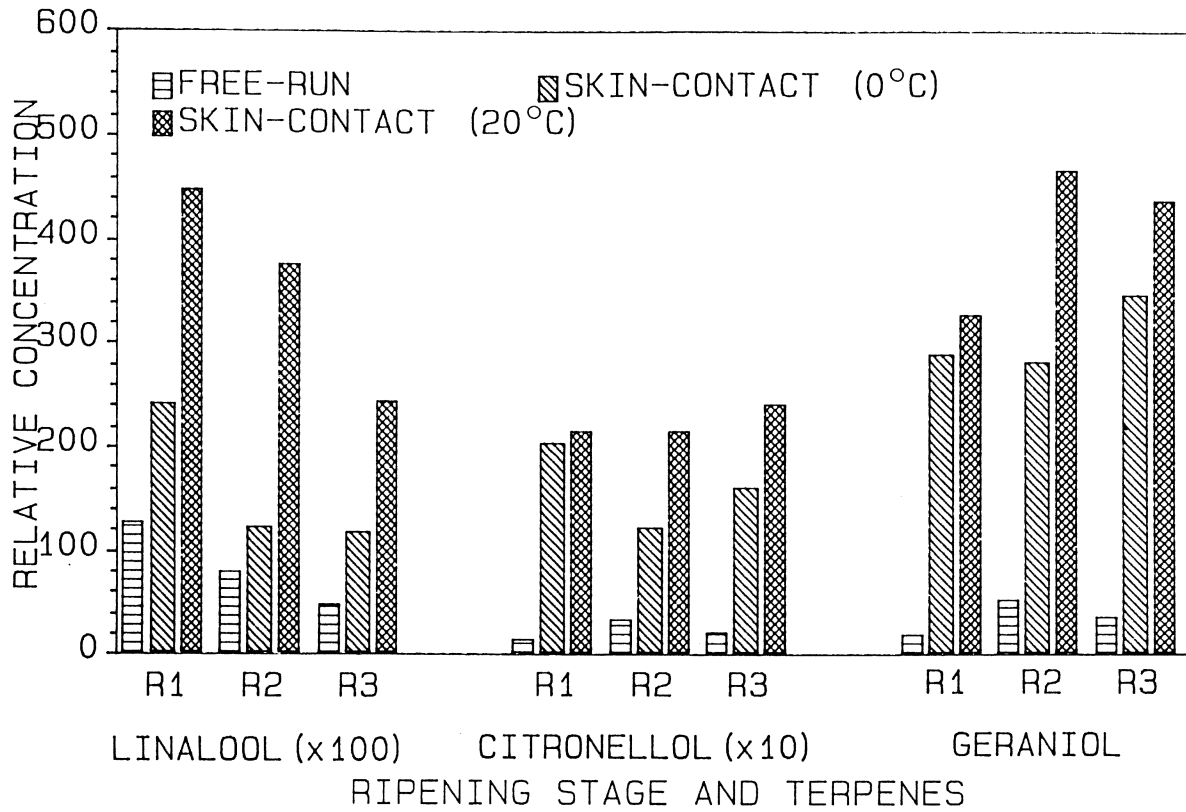


FIG. 3

Effect of skin-contact (4 hours and 15 hours) on terpene concentrations in Gewürztraminer juices and corresponding wines, and on wine quality of Gewürztraminer wines over ripening stages and vintages (FR = Free-run, SC (4) = Skin-contact for 4 hours, SC (15) = Skin-contact for 15 hours). Bars (treatments) topped by the same letter do not differ significantly ($P \leq 0,10$).

A: JUICE



B: WINE

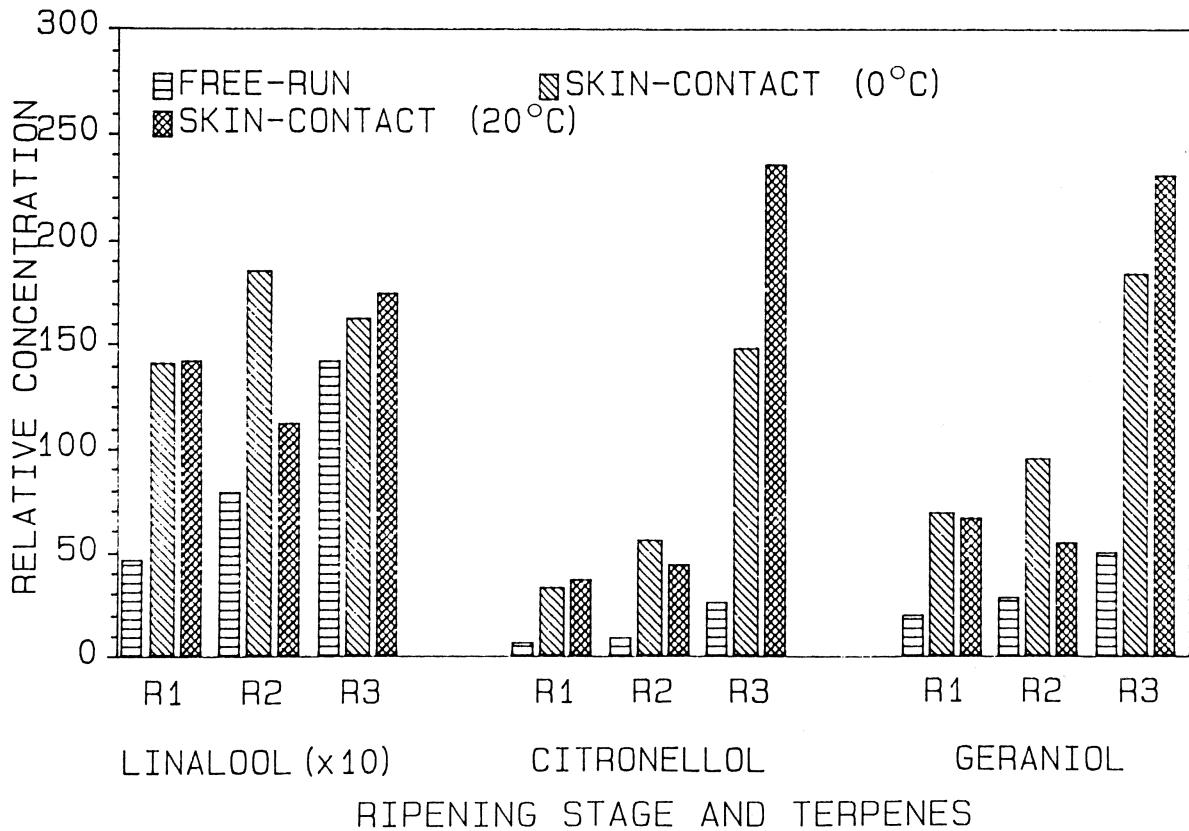
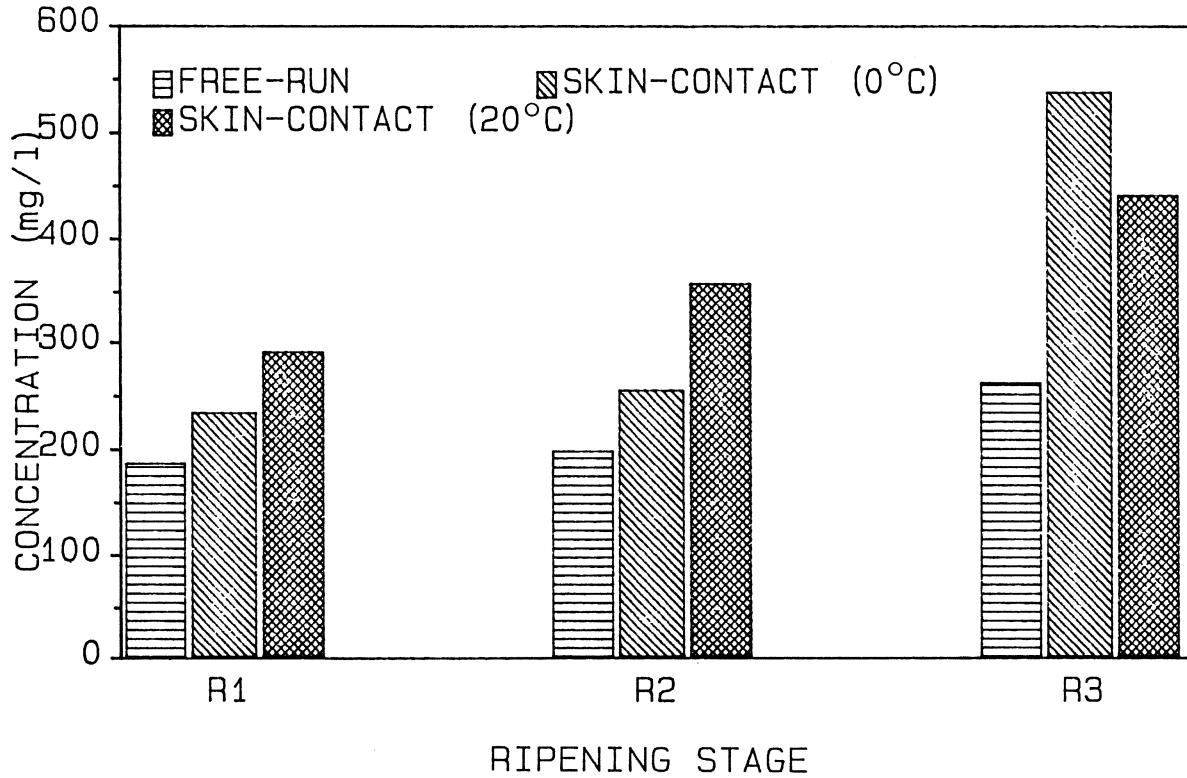


FIG. 4

Effect of skin-contact temperature (0°C and 20°C) on terpene concentrations in 1987 Gewürztraminer juices (A) and corresponding wines (B) at different ripening stages (R1 = 18,0°B, R2 = 21,5°B and R3 = 23,8°B). Skin-contact time = 20 hours. Terpenes are expressed as relative concentrations, using a calibration factor of 1.

A: TOTAL PHENOLS



B: INDIVIDUAL PHENOLS

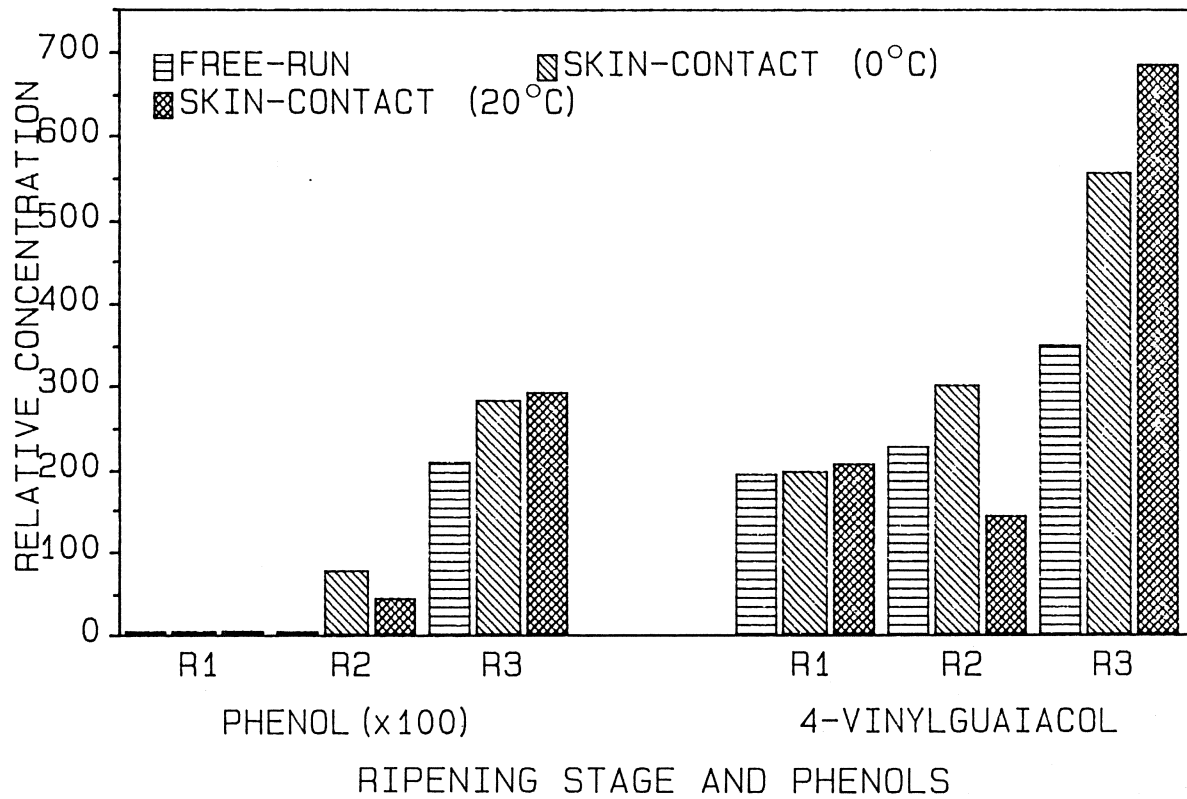


FIG. 5

Effect of skin-contact temperature (0°C and 20°C) on total (A) and individual (B) phenol compound concentrations in 1987 Gewürztraminer wines at different ripening stages (R1 = 18,0°B, R2 = 21,5°B and R3 = 23,8°B). Skin-contact time = 20 hours. Individual phenol compounds are expressed as relative concentrations, using a calibration factor of 1.

stages 1 and 2 (Fig. 5A). These results confirmed similar findings of Ramey *et al.* (1986) in their studies on Chardonnay. At ripening stage 3 a lower total phenol concentration was observed at 20°C than at 0°C skin-contact. This contradictory finding could possibly be ascribed to polymerisation of phenolic compounds and settling thereof before bottling and total phenol analysis.

Although it appears as if total phenol concentrations differed slightly between treatments in some cases (Fig. 5A), a slight increase in total phenol concentration may have a prominent effect on wine quality, since individual phenol compounds could play an important role. Figure 5B illustrates the effect of skin-contact temperature on the concentrations of phenol and 4-vinylguaiacol. An increase in skin-contact temperature from 0°C to 20°C resulted in slight increases in phenol and 4-vinylguaiacol concentrations at ripening stages 3 and 1 respectively and a marked increase in 4-vinylguaiacol concentration at ripening stage 3. The reasons for decreases in the concentrations of both phenol compounds at ripening stage 2 (skin-contact, 20°C) are not clear.

Phenol occurred in very low concentrations and it can be assumed that it has no effect on wine quality. Vinylguaiacol on the other hand occurred in relatively high concentrations (Fig. 5B) and is a very interesting compound. According to Versini (1985), 4-vinylguaiacol could be a main contributor to the characteristic aroma of Gewürztraminer, which implies a positive effect of this compound on wine quality. The necessity to analyse more individual phenol compounds in future studies and their effect after skin-contact on wine quality is obvious.

Skin-contact caused marked increases in N-(3-methylbutyl)-acetamide concentration (Table 1). An increase in skin-contact temperature from 0°C to 20°C also resulted in marked increases in the concentration of this compound. Similarly Rapp *et al.* (1985) illustrated prominent increases in the concentrations of N-(2-methylbutyl)-acetamide, N-(3-methylbutyl)-acetamide, N-(2-phenylethyl)-acetamide and N-methionyl-acetamide in Weisser Riesling wines with an increase in skin-contact time from 0 hours to 20 hours. Acetamides are responsible for metallic and bitter-like flavours in wines (unpublished data).

TABLE 1

Effect of skin-contact temperature on N-(3-methylbutyl)-acetamide concentration in Gewürztraminer wines at different ripening stages.

Ripening stage	Juice treatment		
	FR	SC (0°C)	SC (20°C)
R1 (18,0°B)	9,133	32,773	55,457
R2 (21,5°B)	48,873	82,164	157,315
R3 (23,8°B)	37,751	161,913	326,977

N-(3-methylbutyl)-acetamide is expressed as relative concentrations, using a calibration factor of 1

FR = Free-run control
 SC (0°C) = Skin-contact at 0°C for 20 hours
 SC (20°C) = Skin-contact at 20°C for 20 hours

The effect of skin-contact temperature on terpene-like character, cultivar authenticity and overall wine quality of the 1987 Gewürztraminer wines is illustrated in Fig. 6.

In nearly all cases, the terpene-like character, cultivar authenticity and overall quality of the wines produced from the skin-contact treatments tended to be higher than those of the free-run control. This correlates with the corresponding terpene concentrations. Furthermore, skin-contact at 0°C produced wines of higher intensities of terpene-like character, cultivar authenticity and also overall wine quality than those which had skin-contact at 20°C (Fig. 6). Although these differences were relatively small, the wines produced at 20°C skin-contact were described by the panel as coarse and bitter. These observations correlated with the higher total phenol and N-(3-methylbutyl)-acetamide concentrations of the same wines (Fig. 5A, Table 1). It, therefore, appears that the highest quality wines will be produced from skin-contact at lower temperatures.

The terpenes analysed in this study are not necessarily solely responsible for the typical character of Gewürztraminer, but some of them would certainly make an important contribution. Furthermore, the results obtained in this study for Gewürztraminer could quite possibly apply to other aroma-rich cultivars.

Grape temperature during harvesting and further treatments, plays an important role, especially under hot climatic conditions. Cooler grapes would produce higher quality wines. In South Africa, maximum day temperatures above 30°C during grape maturation are not exceptional (Pienaar, 1986). Therefore, viticultural and oenological practices must be focused on the elimination of the negative effects of high temperature as far as possible.

CONCLUSIONS

An increase in skin-contact time and temperature caused increases in terpene concentrations in Gewürztraminer juices and wines. Furthermore, an increase in skin-contact temperature, in most cases, also resulted in increases in the concentrations of phenols and N-(3-methylbutyl)-acetamide in Gewürztraminer wines. Wines produced from juice subjected to low temperature skin-contact were generally of a higher quality than those wines produced from the free-run juice or juice subjected to skin-contact at elevated temperatures.

Skin-contact is an effective technique which can be applied to extract additional aroma compounds, such as terpenes, from grape skins during wine production. The aroma intensity and quality of wines from cultivars with skins rich in terpenes, may therefore be enhanced. Skin-contact may, however, also result in the extraction of skin compounds detrimental to wine quality, such as certain phenols and acetamides. The temperature at which skin-contact is applied would therefore be of critical importance. Harvesting during the night, cooling of the grapes before or after crushing and skin-contact at low temperatures would benefit the production of wines with higher varietal qualities.

This study should be expanded to other cultivars, and more practical skin-contact temperatures of 5°C and higher should be tested. Repetitions over a number of

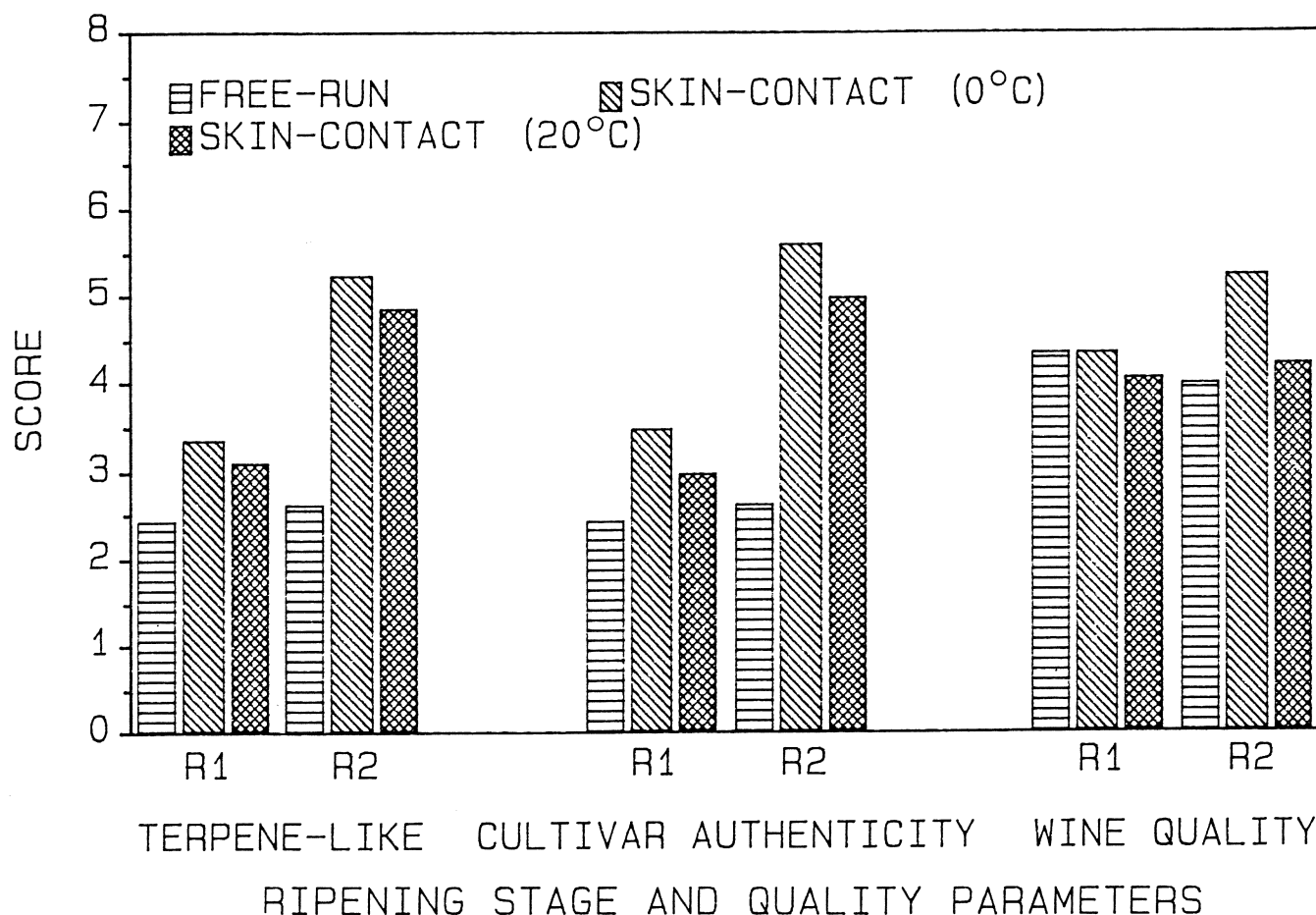


FIG. 6

Effect of skin-contact temperature (0°C and 20°C) on terpene-like character, cultivar authenticity and overall wine quality of 1987 Gewürztraminer wines at different ripening stages (R1 = 18,0°B and R2 = 21,5°B). Skin-contact time = 20 hours.

years, would allow statistical evaluations of the results. The optimum skin-contact time/temperature combination for the production of high quality cultivar wines should be sought.

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