



## Research Communications

# The influence of dry matter of different alcoholic beverages on lipids, proteins, and antioxidant activity in serum of rats

Shela Gorinstein, Marina Zemser, Moshe Weisz, Ratiporn Haruenkit,\*  
and Simon Trakhtenberg<sup>†</sup>

Department of Pharmaceutical Chemistry, School of Pharmacy, The Hebrew University of Jerusalem, Jerusalem, Israel; \*Department of Agricultural Industry, Faculty of Agricultural Technology, King Mondkut Institute of Technology, Ladkrabang, Bangkok 10520, Thailand; <sup>†</sup>Institute of Cardiology, Kaplan Hospital, Rehovot, Israel

*In many western industrialized countries alcoholic beverages are an invariable component of different diets. In the last couple years evidence that moderate consumption of alcoholic beverages leads to some beneficial changes in lipid metabolism and in this way reduces the morbidity and mortality from coronary artery disease (CAD) has been found. In this study we examined the influence of diets supplemented with different lyophilized wines and beer on lipids, proteins, and antioxidant activity in serum of rats. The investigation was conducted on 60 male Wistar rats, divided into three experimental (EG) and one control (CG) groups, each comprised of 15 animals. The rats of the three EGs were fed basic diet (BD) supplemented with South African (SA) dry red wine (EG1), SA dry white wine (EG2), and Israeli Maccabee beer (EG3). The rats of the CG were fed BD only. During 4 weeks of our experiment the animals of EG3 were fed BD supplemented with lyophilized beer at a concentration corresponding to an intake of 6.0 mL of original beer and the rats of EG1 and EG2 were fed BD supplemented with lyophilized wine at a concentration 2.0 mL of original wine daily. Before and after completion of the trial we performed a wide range of laboratory tests including lipids, proteins, and lipid peroxides. The results of our investigation reveal that the dry matter of red wine and beer are the most effective beverages: they exercise beneficial lipidemic and antioxidant effects by reducing total cholesterol (TC), triglycerides, and lipid peroxides and elevating high-density lipoprotein (HDL-C)/TC ratio. All used beverages do not effect the level of proteins in serum of the rats. (J. Nutr. Biochem. 9:131–135, 1998) © Elsevier Science Inc. 1998*

**Keywords:** lyophilized wine; beer; lipids; proteins; lipid peroxides; rat

### Introduction

As early as 1913, Anitschkow and Chalataw<sup>1</sup> have shown on rabbits that diet rich in cholesterol develops atheroscle-

rotic changes in arteries—the pathanatomic basis of coronary artery disease (CAD), which is the most dangerous disease in the western industrialized countries.<sup>2,3</sup> It was established that a proper diet that includes vegetables and fruits can prevent atherosclerosis.<sup>4–7</sup> In most western countries alcoholic beverages are part of different diets<sup>8–11</sup> and consist about 4 to 6% of the average energy intake.<sup>12</sup> There are some authors who claim that alcoholic beverages positively influence lipid metabolism of moderate drinkers.<sup>13–17</sup> Our previous work<sup>18</sup> found positive biochemical changes in

---

Address correspondence and reprint requests to Dr. Shela Gorinstein at School of Pharmacy, Hebrew University of Jerusalem, Jerusalem 91120, P.O.B. 12065, Israel.

Dr. Gorinstein is affiliated with the David R. Bloom Center for Pharmacy. Received April 22, 1997; accepted October 21, 1997.

patients with CAD even after a short-term moderate beer consumption. There are conflicting reports about preference of different types of alcoholic beverages. According to Friedman and Kimball<sup>19</sup> and Klatsky et al.<sup>20</sup> wine and beer more than other alcoholic beverages positively influence the lipid metabolism in alcohol consumers. But Choudhury et al.<sup>21</sup> claim that the type of alcoholic beverages have no significant relationship with serum low-density lipoprotein (LDL) and high-density lipoprotein (HDL-C). In the last years it was demonstrated in vitro and in epidemiological and clinical studies that antioxidants of wine prevent the oxidation of LDL-C—the “building material” for atherosclerotic changes.<sup>7,22-24</sup> The most used alcoholic beverages are different kinds of wine and beer. But what is preferable, wine or beer? And if it is wine, then what kind of wine? If lyophilized beverages can positively influence lipids, proteins, and antioxidant activity in serum of rats fed with different diets supplemented by their dry matter? To answer these questions we decided to conduct a proper investigation.

**Methods and materials**

*Wines and beer*

Wines dry red and dry white and beer were freeze-dried and analysis of the necessary components was done. Total phenol content was determined by the Folin-Ciocalteu assay and expressed as gallic acid equivalents.<sup>25</sup> Epicatechin and quercetin were determined by fluorometric and spectroscopic analyses. Quercetin was also determined as total phenol and expressed in molar equivalents of quercetin.<sup>26,27</sup>

*Animals and diets*

We experimented on 60 male Wistar rats with standard weight of 120 g each. All rats were divided into four equal groups: three experimental (EG) and one control (CG), each of 15 animals. The rats were housed individually in stainless steel metabolic cages and fed a basic diet (BD) consisting of 70.5% starch, 18% ovalbumin, 5% salt-mix, 5% sunflower oil, 1% cod liver oil, 0.3% choline chloride, and 0.2% vitamins. The vitamin mixture included (per kg of diet): thiamin, 20 mg; riboflavin, 15 mg; pyridoxin, 10 mg; nicotinamide, 100 mg; calcium pantothenate, 70 mg; and folic acid, 5 mg. The BD was supplemented with lyophilized beverages only for the rats of the three EGs. During a period of 4 weeks the rats of EG1 were fed BD and 2 mL of South African dry red wine every day, the rats of the EG2 were fed BD and 2 mL of South African dry white wine, and the rats of the EG3 were fed BD and 6 mL of Maccabee beer daily. The rats of the CG received BD only. The diets were served once a day at 10 a.m. ad libitum, together with lyophilized beverages and distilled water introduced by stomach intubation. The energy of the BD supplemented with lyophilized beverages for rats of the EGs (397.3 to 401.7 Kcal/100 g of diet), and the energy of the BD for rats of CG (393.7 Kcal/100 g of diet) did not differ significantly.

*Assays*

We recorded the growth of the animals on a weekly basis. Before and after completion of the 4-week feeding period we drew blood samples from the tail vein and performed a wide range of laboratory tests. These tests included inter alia total cholesterol (TC), LDL-C, HDL-C, triglycerides (TG), total protein (TP), albumin (AL), globulin (GL), and lipid peroxides (LP). TC,

**Table 1** The most relevant components of the used wines and beer

Indices	Dry white	Dry red	Beer
Lyophilized weight (g/100 mL)	1.90 ± 0.12	2.80 ± 0.21	3.70 ± 0.29
Alcohol (% volume)	11.34 ± 0.57	11.85 ± 0.58	4.05 ± 0.31
Total polyphenolics (mg/L)	436.2 ± 21.2	2741 ± 198.1	304 ± 15.1
Epicatechin (mg/L)	56.1 ± 2.32	195.1 ± 9.67	65.5 ± 3.15
Quercetin (mg/L)	1.29 ± 0.05	8.11 ± 0.36	0.95 ± 0.04
Caloric content (Kcal/L)	45.65 ± 2.1	48.1 ± 2.1	23.9 ± 1.2

All results are mean values of triplicates ± standard deviation.

LDL-C and HDL-C were determined according to Epstein<sup>28</sup> and Onongbu and Lewis.<sup>29</sup> Total protein was determined by Lowry<sup>30</sup> and LP- by MODP method using Kamiya Biomedical kits.

*Statistical analysis*

To verify the statistical significance of all parameters we calculated the values of means, standard deviation (M ± m) and confidence intervals (CI) of means. To compare several groups we used analysis of variance (ANOVA). The P values of <0.05 were adopted as statistically significant.

**Results**

The composition of the used wines and Maccabee beer before lyophilization is presented in *Table 1*. The wine and beer samples can make a substantial contribution to dietary requirements. The highest amount of total polyphenols, and especially epicatechin and quercetin, were in dry red wine and then in beer, showing the highest antioxidant activity of these beverages.

The results of the growth of the rats of all four groups are summarized in *Table 2*. According to *Table 2*, the addition to the BD of lyophilized beverages did not cause a statistically significant change in diet intake, the body gains of the animals or the efficiency of diets. The results of the TC, LDL-C, HDL-C, and TG tests before and after completion of the investigation are summarized in *Table 3*. Statistical analysis of these data did not find significant differences in the TC, LDL-C, HDL-C, and TG values in all three EGs and CG before the investigation. After 4 weeks of feeding changes in the level of TC in all EGs were found. But statistically significant decrease in the level of TC (P < 0.01 and 0.0125) was registered only in EG1- and EG3-fed BD supplemented by dry red wine and beer, respectively. In the EG2-fed BD supplemented with dry white wine these

**Table 2** The diet intake, body gains, and diet efficiency ratio

Groups	Av. intake of diet (g/4 weeks)	Av. body gain (g/4 weeks)	Diet efficiency ratio
EG1	381.6 ± 54.1	92.0 ± 29.2	0.241 ± 0.051
EG2	378.6 ± 49.6	93.6 ± 29.9	0.247 ± 0.045
EG3	371.9 ± 54.2	91.8 ± 28.8	0.247 ± 0.047
CG	369.8 ± 49.1	89.5 ± 28.8	0.242 ± 0.048

**Table 3** The serum levels of total cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides in mmol/L (mean values, standard deviations and confidence intervals of means)

Indices	EG1	EG2	EG3	CG
Total cholesterol				
Before	2.79 ± 0.2 [2.36–3.22]	2.78 ± 0.21 [2.33–3.23]	2.80 ± 0.2 [2.33–3.23]	2.78 ± 0.19 [2.38–3.18]
After	2.10 ± 0.16 [1.76–2.44]	2.80 ± 0.2 [2.37–3.23]	2.15 ± 0.15 [1.83–2.47]	2.79 ± 0.2 [2.36–3.22]
LDL				
Before	1.18 ± 0.06 [1.05–1.31]	1.19 ± 0.06 [1.16–1.32]	1.18 ± 0.05 [1.16–1.32]	1.20 ± 0.06 [1.07–1.33]
After	0.82 ± 0.04 [0.74–0.9]	1.2 ± 0.06 [1.07–1.33]	0.84 ± 0.04 [0.76–0.92]	1.19 ± 0.05 [1.08–1.30]
HDL				
Before	1.56 ± 0.09 [1.37–1.75]	1.56 ± 0.1 [1.35–1.77]	1.56 ± 0.09 [1.37–1.75]	1.57 ± 0.1 [1.36–1.78]
After	1.26 ± 0.07 [1.11–1.41]	1.57 ± 0.09 [1.38–1.76]	1.27 ± 0.07 [1.12–1.42]	1.58 ± 0.1 [1.37–1.79]
Triglycerides				
Before	0.64 ± 0.04 [0.56–0.72]	0.65 ± 0.04 [0.57–0.73]	0.64 ± 0.04 [0.56–0.72]	0.65 ± 0.04 [0.57–0.72]
After	0.36 ± 0.03 [0.33–0.39]	0.67 ± 0.04 [0.59–0.75]	0.37 ± 0.03 [0.34–0.40]	0.66 ± 0.04 [0.58–0.74]

changes in the level of TC were not statistically significant ( $P < 0.4$ ). According to *Table 3*, after 4 weeks feeding period the changes in the level of TG in all EGs completely repeat the TC changes. Statistically significant decrease in the level of TG in the EG1 and EG3 ( $P$  for both  $<0.01$ ) and not significant decrease in EG2 ( $P < 0.45$ ) were registered. The changes in the level of LDL-C after completion of the experiment basically repeat the changes in TC, but were not statistically significant in all three EGs. After completion of the trial we found that the changes in the level of HDL-C in all EGs were not statistically significant. But it is important

to emphasize that in rats of the EG1 and EG3 the HDL-C/TC ratio has increased from 0.56 and 0.56 to 0.60 and 0.59, respectively.

*Table 4* summarized the protein and lipid peroxides levels in all EGs and CG before and after completion of the investigation. Differences in the levels of total proteins, albumin, globulin, and lipid peroxides in all three EGs and CG before investigation were not statistically significant. After 4 weeks of feeding, changes in the levels of total proteins, albumin, and globulin in three EGs and CG were nonsignificant. However, level of lipid peroxides decreased

**Table 4** The serum levels of total protein, albumin, globulin,<sup>1</sup> and lipid peroxides<sup>2</sup> (mean values, standard deviations, and confidence intervals of means)

Indices	EG1	EG2	EG3	CG
Total protein				
Before	66.1 ± 4.4 [56.7–75.5]	65.9 ± 4.3 [56.7–75.1]	66.0 ± 4.5 [56.4–75.6]	66.2 ± 4.4 [56.8–75.6]
After	66.0 ± 4.4 [56.6–75.4]	66.0 ± 4.4 [56.6–75.4]	66.1 ± 4.5 [56.5–75.7]	66.1 ± 4.4 [56.7–75.5]
Albumin				
Before	45.2 ± 4.1 [36.5–53.9]	45.1 ± 4.0 [36.6–53.6]	45.0 ± 4.1 [36.3–53.7]	45.1 ± 4.0 [36.6–53.6]
After	45.1 ± 4.0 [36.6–53.6]	45.2 ± 4.1 [36.5–53.9]	45.1 ± 4.0 [36.6–53.6]	45.2 ± 4.1 [36.5–53.9]
Globulin				
Before	12.3 ± 3.1 [5.7–18.9]	12.2 ± 3.2 [5.4–19.0]	12.3 ± 3.3 [5.3–19.3]	12.1 ± 3.1 [5.5–18.7]
After	12.2 ± 3.2 [5.4–19.0]	12.3 ± 3.1 [5.7–18.9]	12.2 ± 3.2 [5.4–19.0]	12.2 ± 3.1 [5.5–18.8]
Lipid peroxides				
Before	1.20 ± 0.17 [0.84–1.56]	1.21 ± 0.18 [0.83–1.59]	1.19 ± 0.17 [0.83–1.53]	1.21 ± 0.18 [0.83–1.59]
After	0.54 ± 0.09 [0.35–0.73]	0.70 ± 0.10 [0.49–0.91]	0.55 ± 0.09 [0.36–0.74]	1.20 ± 0.17 [0.84–1.56]

<sup>1</sup> Total protein, albumin and globulin in g/L.

<sup>2</sup> Lipid peroxides in  $\mu\text{mol/L}$ .

in all three EGs after the trial period. This decrease was statistically significant for EG1 and EG3 ( $P < 0.001$  and  $P < 0.005$ , respectively).

## Discussion

In the last few years many authors claim that proper diets can be very effective in prevention of atherosclerosis—the pathanatomic basis of the CAD, which is the most dangerous disease in the western industrialized countries.<sup>5–7</sup> Some investigators propose to include in diets new kinds of vegetables and fruits in order to increase the antilipidemic and antioxidant effects of diets.<sup>31–33</sup> But the role of the old permanent part of diets in the western countries—alcoholic beverages, still needs to be investigated. There are still conflicting reports of the influence on the lipid metabolism and peroxidation of different kinds of wine and beer.<sup>19,21,23</sup> Therefore, we decided to evaluate the influence of diets supplemented with dry red and dry white wines and beer on lipids, proteins, and antioxidant activity of rats. In our previous investigations first on animals<sup>34</sup> and after receiving positive results on patients with CAD<sup>18,35</sup> we studied the influence of alcohol-containing beverages. However, according to some authors<sup>36,37</sup> relatively high alcoholic consumption leads to a prooxidant effect. Therefore, investigation was conducted with different lyophilized alcoholic beverages.

Using alcohol-free beverages we wanted to investigate the influence of their dry matter on lipids, proteins, and antioxidant activity in serum of rats. And in the case of positive influence to continue studies on patients with CAD. An investigation with different alcohol-free beverages would allow us to include patients who do not use alcohol according to their religious believes (about 20% of our population). We used 60 male Wistar rats. They were divided into four equal groups—three EGs and one CG, each of 15 animals. During 4 weeks these groups of animals were fed different diets: EG1—BD and dry red wine; EG2—BD and dry white wine; EG3—BD and beer; and CG—BD only. After completion of the experiment we found that the most marked beneficial effect on lipids exercise dry red wine and beer; these two beverages decrease the level of TC, LDL-C and TG and increase the HDL-C/TC ratio. These results confirm reports on different effect of various alcoholic beverages on lipid metabolism.<sup>17,19,20</sup> It is well known today that the lipids of the atherosclerotic plaques are derived from plasma oxidised LDL-C.<sup>38</sup> Therefore, it was important to examine the antioxidant properties of all three beverages. After completion of the investigation we noted that all beverages exercise antioxidant effect by decreasing the level of lipid peroxides. But the antioxidant action of dry red wine and beer was statistically significantly higher than that of the dry white wine. How it can be explained? It is true that the content of total polyphenolics in dry white wine is statistically significantly higher than in beer. However, the content of epicatechin in beer is statistically significantly higher than in white wine. Epicatechin is one of the unique group of phenolic metabolites of relatively high molecular weight that are named tannins.<sup>39</sup>

It was shown that tannins are 20 times more active than

vitamin E,<sup>32</sup> the main and the possibly only role of which is to act as an antioxidant.<sup>40</sup> It is known that ethanol is oxidized to an extremely reactive metabolite, acetaldehyde, which in turn converts to other products that may be responsible for some adverse effects.<sup>41</sup> Even a short-term ethanol consumption is responsible for reduction in cardiac protein synthesis.<sup>42,43</sup> Can a short-term consumption of lyophilized beverages negatively influence the serum proteins? As we have supposed, after 4 weeks of investigation we did not find any quantitative changes in the serum total protein, albumin and globulin in all three EGs. In conclusion, our investigation demonstrates that among used beverages lyophilized dry red wine and beer more positively effect lipids and the antioxidant activity in serum of rats and do not lead to quantitative changes in serum proteins. Therefore, these two beverages can be used for investigation in patients with CAD to decide if lyophilized alcoholic beverages could be a valuable part of atherosclerosis prevention diet.

## References

- 1 Anitschkow, N. and Chalataw, S. (1913). Uber experimentelle Cholesterinsteatose und ihre Bedeutung fur die Entstehung einiger pathologischer Prozesse. *Ztb. f. alg. Path. u. path. Anat.* **24**, 1–9
- 2 Hennekens, C.H. and Gaziano, J.M. (1993). Antioxidants and heart disease. *Clin. Cardiol.* **16**, 110–116
- 3 Gaziano, J.M. (1994). Antioxidant vitamins and coronary artery disease risk. *Am. J. Med.* **97**, 18S–21S, 22S–28S
- 4 Riemersa, R.A., Wood, D.A., Macintyre, C.C.A., Elton, A., Gey, K.F., and Oliver, M.F. (1991). Risk of angina pectoris and plasma concentration of vitamins A, C and E and carotene. *Lancet* **337**, 1–5
- 5 Gey, K.F., Stahelin, H.B., and Eichholzer, M. (1993). Poor plasma status of carotene and vitamin C is associated with higher mortality from ischemic heart disease and stroke. Basel Prospective Study. *Clin. Investig.* **71**, 3–6
- 6 Longenil, M., Renaud, S., Mamelle, N., Salen, P., Martin, J.L., Monjaud, I., Guidollet, J., Toubolt, P., and Delaye, J. (1994). Mediterranean alpha-linolic acid-rich diet in secondary prevention of coronary heart disease. *Lancet* **343**, 1454–1459
- 7 Partiff, V.J., Rubba, P., Bolton, C., Marotta, G., Hartog, M., and Mancini, M. (1994). A comparison of antioxidant status and free radical peroxidation of plasma lipoproteins in healthy young persons from Naples and Bristol. *Eur. Heart J.* **15**, 871–876
- 8 Lucia, S.P. (1972). Wine: A food throughout the ages. *Am. J. Clin. Nutr.* **25**, 361–362
- 9 McDonald, J. and Margen, S. (1976). Wine versus ethanol in human nutrition. I. Nitrogen and calorie balance. *Am. J. Clin. Nutr.* **29**, 1093–1103
- 10 McDonald, J. and Margen, S. (1979). Wine versus ethanol in human nutrition. II. Fluid, sodium and potassium balance. *Am. J. Clin. Nutr.* **32**, 817–822
- 11 McDonald, J. and Margen, S. (1980). Wine versus ethanol in human nutrition. IV. Zinc balance. *Am. J. Clin. Nutr.* **33**, 1096–1102
- 12 Christiansen, C., Thomsen, C., Rasmussen, D., Hauerslev, C., Balle, M., Hansen, C., and Hermansen, K. (1994). Effect of alcohol on glucose, insulin, free fatty acid and triacylglycerol responses to a light meal in non-insulin-dependent diabetic subjects. *Br. J. Nutr.* **71**, 449–454
- 13 Masarei, J.R., Puddey, I.B., Rouse, I.L., Lynch, W.J., Vandongen, R., and Beilin, L.J. (1986). Effect of alcohol consumption on serum lipoprotein-lipid and apolipoprotein concentrations. Results from an intervention study in healthy subjects. *Atherosclerosis* **60**, 79–87
- 14 Moor, R.D. and Pearson, T.A. (1986). Moderate alcohol consumption and coronary disease. *Medicine* **65**, 246–267
- 15 Frimpong, N.A. and Lapp, J.A. (1989). Effects of moderate alcohol intake in fixed or variable amounts on concentration of serum lipids and liver enzymes in healthy young men. *Am. J. Clin. Nutr.* **50**, 987–991

- 16 Jacson, R., Scragg, R., and Beaglehole, R. (1991). Alcohol consumption and risk of coronary artery disease. *Brit. Med. J.* **303**, 211–216
- 17 Renaud, S. and Lorgeril, M. (1992). Wine, alcohol, platelets and the French paradox for coronary heart disease. *Lancet* **339**, 1523–1526
- 18 Gorinstein, S., Zemser, M., Lichman, I., Kleipfish, A., Berebi, A., Libman, I., Trakhtenberg, S., and Caspi, A. (1997). Moderate beer consumption and the blood coagulation in patients with coronary artery disease. *J. Intern. Med.* **241**, 47–51
- 19 Friedman, L.A. and Kimball, A.W. (1986). Coronary artery disease and alcohol consumption in Framingham. *Am. J. Epidemiol.* **124**, 481–489
- 20 Klatsky, A.L. and Armstrong, M.A. (1993). Alcohol beverages choice and risk of coronary artery disease. Mortality: do red wine drinkers fare best? *Am. J. Cardiol.* **71**, 467–469
- 21 Choudhury, S.R., Ueshima, H., Kita, Y., Kobayashi, K.M., Okayama, A., Yamakawa, M., Hirao, Y., Ishikawa, M., and Miyoshi, Y. (1994). Alcohol intake and serum lipids in Japanese population. *Int. J. Epidemiol.* **23**, 940–947
- 22 Yugarani, T., Tan, B.K.H., Teh, M., and Das, N.F. (1992). Effects of polyphenolic natural products on the lipid profiles of rats fed high fat diets. *Lipids* **27**, 181–186
- 23 Frankel, E.N., Kanner, J., German, J.B., Parks, E., and Kinsella, J.E. (1993). Inhibition of oxidation of human low density lipoprotein by phenolic substances of red wine. *Lancet* **341**, 454–457
- 24 Hartog, M.G.L., Feskens, E.J.M., Hollman, P.C.H., Katan, M.B., and Kromhouy, D. (1993). Dietary antioxidant flavonoid and risk of coronary heart disease: the Zutphen Elderly Study. *Lancet* **342**, 1007–1009
- 25 Gorinstein, S., Zemser, M., Weisz, M., Halevy, S., Deutsch, J., Tilis, K., Feintuch, D., Fishman, M., and Bartnikowska, E. (1994). Fluorometric analysis of phenolics in persimmons. *Biosci. Biotech. Biochem.* **58**, 1087–1092
- 26 Gorinstein, S., Weisz, M., Zemser, M., Tilis, K., Stiller, A., Flam, I., and Gat, Ya. (1993). Spectroscopic analysis of polyphenols in white wines. *J. Ferm. & Bioeng.* **75**, 115–120
- 27 Cela, R., Natera, R., and Perez-Bustamante, J.A. (1982). Determination of total polyphenols in musts and white wines. *An. Bromatol.* **34**, 207–217
- 28 Epstein, F.H. (1971). Epidemiologic aspects of atherosclerosis. *Atherosclerosis* **14**, 1–11
- 29 Onongbu, I.C. and Lewis, B. (1976). Lipoprotein fractionation by a precipitation method. A simple quantitative procedure. *Clin. Chim. Acta* **71**, 397–402
- 30 Lowry, O.H., Rosenbrough, N.J., Farr, A.L., and Randall, R.J. (1951). Protein measurement with Folin phenol reagent. *J. Biol. Chem.* **193**, 265–270
- 31 Kirby, R.W., Anderson, J.W., Sieling, B., Reeds, E., Chen, W.J.L., Miller, R.E., and Kay, R.M. (1981). Oat bran intake selectively lowers serum low density lipoprotein cholesterol concentration of cholesterolemic men. *Am. J. Clin. Nutr.* **34**, 824–829
- 32 Uchida, S., Ohta, H., Edamatsu, R., Hiromatsu, M., Mori, A., Nonaka, G.I., Nishioka, I., Akashi, T., Niwa, M., and Ozaki, M. (1989). Persimmon tannin prolongs the life span of stroke-prone spontaneously hypertensive rats (SHRSP) by acting as a free-radical scavenger. In *New Horizons in Preventing Cardiovascular Diseases* (Y. Yamori, and T. Strasser, eds.), p. 13–17. Elsevier, Amsterdam, The Netherlands
- 33 Lin, R. (1994). Nutritional antioxidants. In *Phytochemical and Antioxidant Functional Food* (I. Goldberg, ed.), p. 393–455. Chapman and Hall, New York, USA
- 34 Gorinstein, S. (1986). Nutritional and metabolic indices in beverages after enzymatic degradation of starch. *Nutr. Rep. Inter.* **34**, 529–539
- 35 Gorinstein, S., Zemser, M., Berliner, M., Goldstein, R., Libman, I., Trakhtenberg, S., and Caspi, A. (1997). Moderate beer consumption and some positive biochemical changes in patients with coronary atherosclerosis. *J. Intern. Med.* **242**, 219–224
- 36 Fuhrman, D., Lavy, A., and Aviram, M. (1995). Consumption of red wine with meals reduces the susceptibility of human plasma and low density lipoprotein to lipid peroxidation. *Am. J. Clin. Nutr.* **61**, 549–554
- 37 Croft, K.D., Puddey, I.B., Rakic, V., Abu-Amsha, R., Dimmit, S.B., and Beilin, L.J. (1996). Oxidative Susceptibility of Low-Density Lipoproteins—Influence of Regular Alcohol Use. *Alcohol. Clin. Exp. Res.* **20**, 980–984
- 38 Steinberg, D., Parthasarathy, C., Carew, T., Khoo, J., and Witztum, J. (1989). Beyond cholesterol: modification of low density lipoprotein that increases its atherogenicity. *N. Engl. J. Med.* **320**, 915–924
- 39 Harborne, J.B. (1989). Tannins. In *Methods in Plant Biochemistry* (J.B. Harborne, ed.), p. 389–390. Academic Press, London
- 40 Willis, E.D. (1985). Vitamin E (Tocopherols). In *Oxidative Stress* (H. Sies, ed.), p. 211–214. Academic Press, London
- 41 Preedy, V.R., Siddiq, T., Why, H., and Ricardson, P.J. (1994). Ethanol toxicity and cardiac protein synthesis in vivo. *Am. Heart J.* **127**, 1432–1439
- 42 Preedy, V.R., Siddiq, T., Cook, E., Black, D., Palmer, T.N., and Peters, T.J. (1991). Alcohol and protein turnover. In *Alcoholism: A Molecular Perspective*. (T.N. Palmer, ed.), p. 253–273. Plenum Press, New York, USA
- 43 Preedy, V.R. and Peters, T.J. (1992). Protein metabolism in alcoholism. In *Nutrition and Alcohol* (R.R. Watson and B. Watzl, eds.), p. 143–189. CRC Press Inc., Boca Raton, FL, USA