Regular, high, and moderate intake of vegetables rich in antioxidants may reduce cataract risk in Central African type 2 diabetics

Moise Mvu1
Benjamin Longo-Mbenza2
Dieudonné Tulomba3
Augustin Nge3

1Department of Ophthalmology, University of Kinshasa, Democratic Republic of Congo; 2Faculty of Health Sciences, Walter Sisulu University, South Africa; 3Biostatistics Unit, Lomo Medical Center and Heart of Africa Center of Cardiology, Kinshasa, Democratic Republic of Congo

Background: Antioxidant nutrients found in popularly consumed vegetables, including red beans, are thought to prevent diabetic complications. In this study, we assessed the frequency and contributing factors of intake of fruits and vegetables rich in antioxidants, and we determined their impact on the prevention of diabetes-related cataract extraction.

Methods: This was a cross-sectional study, run in Congo among 244 people with type 2 diabetes mellitus. An intake of ≥ three servings of vegetables rich in antioxidants/day, intake of red beans, consumption of fruit, and cataract extraction were considered as dependent variables.

Results: No patient reported a fruit intake. Intake of red beans was reported by 64 patients (26.2%), while 77 patients (31.6%) reported ≥ three servings of vegetables rich in antioxidants. High socioeconomic status (OR = 2.3; 95% CI: 1.1–12.5; P = 0.030) and moderate alcohol intake (OR = 4; 95% CI: 1.1–17.4; P = 0.049) were the independent determinants of eating ≥ three servings of vegetables rich in antioxidants. Red beans intake (OR = 0.282; 95% CI: 0.115–0.687; P < 0.01) and eating ≥ three servings of vegetables rich in antioxidants (OR = 0.256; 95% CI: 0.097–0.671; P = 0.006) were identified as independent and protective factors against the presence of cataracts (9.8% n = 24), whereas type 2 diabetes mellitus duration ≥ 3 years was the independent risk factor for cataract extraction (OR = 6.3; 95% CI: 2.1–19.2; P < 0.001 in the model with red beans intake and OR = 7.1; 95% CI: 2.3–22.2; P < 0.001 in the model with ≥ three servings of vegetables rich in antioxidants).

Conclusion: Red beans intake and adequate quantity of intake of vegetables rich in antioxidants were found to be associated with reduced risk of cataract in these Congolese with type 2 diabetes mellitus. Education on nutrition and health promotion programs are needed to encourage people to eat vegetables and fruit.

Keywords: red beans, cataract extraction, socioeconomic status, public health implications

Introduction
Diabetes mellitus (DM) is defined by chronic hyperglycemia which induces reactive oxygen species and reactive nitrogen species via protein kinase C and nitrogen-activated protein kinase. The concept of oxidative stress corresponds to an abnormal metabolism with an imbalance between the oxidant production rate and the rate of oxidant degradation.

The role of reactive oxygen species-related oxidative stress in the pathogenesis of cataracts is well documented in the literature.1

Dietary antioxidants may prevent cataract formation.2 In the Democratic Republic of Congo (DRC), our country, adults do not eat salads and cabbage or fresh green vegetables because of cultural reasons and the low socioeconomic status (SES) of...
the majority of the population. They prefer burned and well-cooked vegetables that are poor in carotenoids and retinoids. They do not consume fruit, as fruits are thought to be harmful for people with type 2 diabetes mellitus (T2 DM). Fortunately, red beans are considered the “meat” of the Congolese population, and are cooked mixed with different vegetables also rich in antioxidants. Dietary antioxidants prevent cataract formation by preventing the oxidation of proteins or lipids within the lens in general and during aging also related to oxidative stress. There is a lack of African studies and health policy about the role of red beans in the prevention of cataracts among people with T2 DM.

Therefore, the aims of this study were to assess the levels and the factors associated with adequate intake of vegetables rich in antioxidant intake, and to determine their impact in the prevention of DM-related cataract extraction.

**Material and methods**

This was a cross-sectional study, conducted among 244 consecutive Congolese patients managed for T2 DM at the Diabetes Outpatients Clinic of the General Hospital of Kinshasa, DRC, between October 2008 and March 2009. The study protocol was approved by the local Ethics Committee and was conducted according to the principles of Helsinki Declaration II. After informed and verbal consent (the majority of participants had low levels of education), examination methods included an interviewer-administered structured and standardized questionnaire and measurement of weight and height. Self-reported items included age, gender, profession, ethnicity, residence, education level, rural–urban migration, personal history of cataract extraction, and other lifestyle factors.

**Dietary assessment**

To assess dietary intake, a qualitative-type questionnaire about the frequency of vegetable consumption was used. We also used a semiquantitative food-frequency questionnaire adapted from the World Health Organization STEPwise approach. The participants were asked about the average number of servings of vegetables rich in antioxidants including red beans they consumed per day in a typical week.

**Definitions**

Vegetables rich in antioxidants were defined by source, total antioxidant capacity per serving size and by their composition in vitamins C, E, A, carotenoids, lycopenes and/or eaten crude or green included Brassica oleracea (garden cabbage), lettuce, Colocasia antiquorum (feuille de taro), Phacelia globosa (fougère), Phaseolus vulgaris (beans), Lycopersicum esculentum (tomato), Musa acuminate (plantain), and Solanum aethiopicum (Ethiopian eggplant named solo in Lingala language of DRC). Qualitatively, a regular intake of fruits or red beans mixed with vegetables rich in antioxidants was contrasted with no intake of the same. Daily smoking of one cigarette and alcohol intake (beer: excessive intake, ≥four glasses/day in men and ≥three glasses/day in women; moderate intake, one to three glasses/day) were defined according to WHO STEPwise approach. Self-reported ethnicity included the Kongo tribe from the south-west of DRC, the Ngala tribe from the north-west of DRC, the Luba tribe from the centre of DRC, and the Swahili people from the eastern part of DRC. Residential environment was rural for the Lukunga and Tshangu districts, and urban for the Funa and Mont Amba districts. Educational level included illiteracy, primary school, high school, and university. Obesity was defined by body mass index (=weight in kg/height in m²) ≥30 kg/m². SES included low (lack of income, unemployment) and high SES.

**Statistical analysis**

The unit of analysis was individuals, rather than eyes, because eyes were not examined independently. Data were reported as proportions (%) for categorical variables and mean ± standard deviation for continuous variables. The Chi-square test was used to compare proportions (%), while comparisons of means between groups were performed using the Student's t-test. The univariate risk of cataract extraction was assessed by calculating the odds ratio (OR) with 95% confidence intervals (95% CI). Multivariate analysis such as the logistic regression model was used to assess the independent effect of selected variables on regular intake of vegetables and the presence of cataract extraction after adjusting for the effect of other potential confounders.

A P-value <0.05 was considered significant. Data analysis was carried out using the Statistical Package for Social Sciences (SPSS) for Windows version 13 (SPSS Inc, Chicago, IL).

**Results**

Two hundred and forty four patients with T2 DM were finally assessed, and their findings were subjected to statistical analysis. The mean age of all participants was 48 ± 16 years (range: 12 years to 80 years). The median DM duration
was 3 years, DM duration ≥3 years being considered long. The general characteristics of the study population were dominated by low educational level, low SES, rural–urban migration, and Kongo ethnic group (see Table 1).

No patient (0%) reported intake of fruits. Intake of red beans was reported by 64 patients (26.2%), while 77 patients (31.6%) recognized eating ≥three servings of vegetables rich in antioxidants.

In univariate analysis, moderate alcohol intake, high SES, high educational level, and urban residence were the factors associated significantly and positively with the consumption of vegetables rich in antioxidants (see Table 2).

After adjusting for gender, age, migration, total obesity, smoking, residential environment, and ethnicity, only high SES and moderate alcohol intake were identified as independent and significant determinants of the consumption of vegetables rich in antioxidants (see Table 3).

Intake of red beans (OR = 0.3; 95% CI: 0.1–0.7; P = 0.003) and intake of ≥three servings of vegetables rich in antioxidants (OR = 0.29; 95% CI: 0.1–0.6; P = 0.009) were negatively and significantly associated with the presence of cataracts. Rural residence (OR = 1.6; 95% CI: 1.1–4.3; P = 0.036), cigarette smoking (OR = 1.5; 95% CI: 1.2–6.8; P = 0.040), DM duration ≥3 years (OR = 4.2; 95% CI: 2.1–20.2; P < 0.0001), and rural–urban migration (OR = 1.4; 95% CI: 1.08–11.2; P = 0.047) were the univariate factors for cataract extraction.

When the number of servings of vegetables rich in antioxidants was not introduced in the first logistic regression analysis (Model 1) which was adjusted for residence, cigarette smoking, and migration, only red beans intake (protective role) and DM ≥3 years (conferring sixfold risk) were independently and significantly associated with the presence of cataract extraction (see Table 4).

The second logistic regression analysis (Model 2) did not include red beans intake and was adjusted for residence, cigarette smoking, and migration (see Table 5). Only DM duration ≥3 years (sevenfold risk) and intake of ≥three servings of vegetables rich in antioxidants/day (protective role) were independently and significantly associated with the presence of cataract extraction (see Table 5).

**Discussion**

To our knowledge, this is the first African study of the prevention of cataracts by vegetables rich in antioxidants in general, and by red beans in particular.

### Table 1 General characteristics of the study population

| Variables                                | n | %    |
|------------------------------------------|---|------|
| Gender                                   |   |      |
| Males                                    | 106 | 43.4 |
| Females                                  | 138 | 56.6 |
| Low socioeconomic status                 | 190 | 77.9 |
| Rural–urban migration                    | 151 | 61.9 |
| Ethnicity                                |   |      |
| Kongo                                    | 147 | 60.2 |
| Luba                                     | 45  | 18.4 |
| Swahili                                  | 28  | 11.5 |
| Ngala                                    | 24  | 9.8  |
| Rural residential environment            | 137 | 56.2 |
| Low educational level                    | 191 | 78.3 |
| Cigarette smoking                        | 32  | 13.1 |
| Moderate alcohol intake                  | 34  | 13.9 |
| Cataract extraction                      | 24  | 9.8  |
| Total obesity                            | 37  | 15.7 |

### Table 2 Factors associated with consumption of ≥three servings of vegetables rich in antioxidants

| Variables of interest | Intake of vegetables rich in antioxidants n (%) |
|-----------------------|-----------------------------------------------|
| Gender                |                                               |
| Male                  | 9 (8.5%)                                      |
| Female                | 11 (8%)                                       |
| P-value               | >0.05                                         |
| Residential environment|                                          |
| Rural                 | 9 (6.6%)                                      |
| Urban                 | 11 (10.3%)                                    |
| P-value               | 0.040                                         |
| Educational level     |                                               |
| Low                   | 15 (7.9%)                                     |
| High                  | 5 (9.4%)                                      |
| P-value               | 0.031                                         |
| Ethnicity             |                                               |
| Kongo                 | 11 (7.5%)                                     |
| Ngala                 | 2 (8.3%)                                      |
| Luba                  | 4 (8.9%)                                      |
| Swahili               | 3 (10.7%)                                     |
| P-value               | 0.947                                         |
| Socioeconomic status  |                                               |
| Low                   | 21 (11.1%)                                    |
| High                  | 2 (3.8%)                                      |
| P-value               | 0.029                                         |
| Alcohol intake        |                                               |
| Moderate              | 21 (61.8%)                                    |
| Abstinence            | 21 (10%)                                      |
| P-value               | <0.0001                                       |

**Abbreviations:** CI, confidence interval; OR, odds ratio.

### Table 3 Independent determinants of consumption of vegetables rich in antioxidants

| Independent variables | OR (95% CI) | P-value |
|-----------------------|-------------|---------|
| High socioeconomic status | 2.3 (1.1–12.5) | 0.030 |
| Moderate alcohol intake | 4 (1.1–17.4)  | 0.049  |
The present study adds support for recommendations to consume vegetables rich in antioxidants, including red beans. Indeed, carotenoids, retinoids, lutein, and zeaxanthin may decrease the risk of developing cataracts severe enough to require surgical extraction. Clinicians could educate and prescribe dietary supplements rich in antioxidants both for the general public and for diabetic patients.

A public health message must be tailored to improve adherence by the Kinshasa population, in particular. Education about appropriate diet and the protective effects of moderate alcohol intake should be promoted among patients with T2 DM. The Government is invited to relieve poverty.

**Clinical perspectives and implications for public health**

The subject of antioxidants in food has become a hot topic over the last few years, and for good reason.

The present study adds support for recommendations to consume vegetables rich in antioxidants, including red beans. Indeed, carotenoids, retinoids, lutein, and zeaxanthin may decrease the risk of developing cataracts severe enough to require surgical extraction. Clinicians could educate and prescribe dietary supplements rich in antioxidants both for the general public and for diabetic patients.

A public health message must be tailored to improve adherence by the Kinshasa population, in particular. Education about appropriate diet and the protective effects of moderate alcohol intake should be promoted among patients with T2 DM. The Government is invited to relieve poverty.

**Limitations**

The present study may be limited to some degree because of its cross-sectional design which is not capable of demonstrating a causal association between the identified determinants and cataract extraction. Endogenous biomarkers of oxidative stress and antioxidant status were not measured in blood samples of these Congolese patients with T2 DM.

Dietary assessment based on single self-report may introduce measurement errors and attenuate the association between variables.

**Conclusion**

In conclusion, cultural beliefs and poverty do not facilitate the intake of vegetables rich in antioxidants which may be protective against cataract formation.

---

**Table 4 Independent determinants of presence of cataract extraction in model 1**

| Independent variables | Beta coefficient | Standard error | OR (95% CI) | P-value |
|-----------------------|------------------|----------------|-------------|---------|
| Red beans intake      |                  |                |             |         |
| Yes vs no             | −1.268           | 0.455          | 0.282 (2.3–22.2) | <0.01   |
| DM duration           |                  |                |             |         |
| ≥3 years vs <3 years  | 1.837            | 0.571          | 6.3 (2.1–19.2) | <0.0001 |

**Abbreviations:** CI, confidence interval; DM, diabetes mellitus; OR, odds ratio.

**Table 5 Independent determinants of presence of cataract extraction in model 2**

| Independent variables | Beta coefficient | Standard error | OR (95% CI) | P-value |
|-----------------------|------------------|----------------|-------------|---------|
| DM duration           |                  |                |             |         |
| ≥3 years vs <3 years  | 1.966            | 0.578          | 7.1 (2.3–22.2) | <0.0001 |
| Number of servings of vegetables in antioxidants |                  |                |             |         |
| ≥three/day vs <three/day | −1.364        | 0.492          | 0.256 (0.097–0.671) | 0.006   |
| Constant              | −2.487           | 0.576          | <0.0001     |         |

**Abbreviations:** CI, confidence interval; DM, diabetes mellitus; OR, odds ratio.
Disclosures
Lomo Medical Center, Kinshasa, DR Congo, supported this study by supplying research funds. The authors report no conflicts of interest in this work.

References
1. Vinson JA. Oxidative stress in cataracts. Pathophysiology. 2006;13(3):151–162.
2. Shibata S, Natori Y, Nishihara T, et al. Antioxidant and anti-cataract effects of Chlorella on rat with streptozotocin-induced diabetes. J Nutr Sci Vitaminol (Tokyo). 2003;49(5):334–339.
3. World Health Organization. WHO STEPS Surveillance Manual: The WHO STEPwise approach to chronic disease risk factor surveillance. Geneva: WHO Press; 2005.
4. Wu SY, Leske MC. Antioxidants and cataract formation: a summary review. Int Ophthalmol Clin. 2000;40(4):71–81.
5. Christen WG. Antioxidant vitamins and age-related eye disease. Proc Assoc Am Physician. 1999;11(1):16–21.
6. Bhuyan KC, Bhuyan DK. Molecular mechanism of cataractogenesis. III. Toxic metabolites of oxygen as initiators of lipid peroxidation and cataract. Curr Eye Res. 1984;3:67–81.
7. Pollack A, Oren P, Stark AH, Eisner Z, Nyska A, Madar Z. Cataract development in sand and galactosemic rats fed a natural tomato extract. J Agric Food Chem. 1999;47(12):5122–5126.
8. Bonnefoy M, Drei J, Kostka T. Antioxidants to slow aging, facts and perspectives. Presse Med. 2002;31(5):1174–1184. French.
9. Tappy L, Würsch P, Randin JP, Felber JP, Jéquier E. Metabolic effect of pre-cooked instant preparations of bean and potato in normal and in diabetic subjects. Am J Clin Nutr. 1986;43:30–36.
10. Hiller R, Sperduto RD, Ederer F. Epidemiologic associations with cataract in the 1971–1972 National Health and Nutrition Examination Survey. Am J Epidemiol. 1983;118:239–249.
11. Shane-McWhorter L, Geil P. Interactions between complementary therapies or nutrition supplements and conventional medications. Diabetes Spectrum. 2002;15(4):262–266.
12. Guerrero-Romero F, Rodriguez-Morán M. Complementary therapies for diabetes: the case for chromium, magnesium, and antioxidants. Arch Med Res. 2005;36:250–257.