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Epidemiology

Micronutrient content and antioxidant enzyme activities in human breast milk

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Highlights

- Micronutrient content, antioxidant enzyme activity were quantified in breast milk.
- SOD, GPx and GST activities increased with the number of pregnancies.
- Women with BMI <25 had greater GST activity.
- Correlations between micronutrients and antioxidant activity were found.
- Antioxidant enzymes and micronutrients prevent oxidation of molecules in breast milk.

Abstract

Breast milk contains micronutrients that function as cofactors of antioxidant enzymes. High concentrations of iron (Fe) and copper (Cu) can increase the production of reactive oxygen species (ROS). This study aimed to assess the relationship between the activity of antioxidant enzymes (superoxide dismutase (SOD), catalase, glutathione peroxidase (GPx), glutathione reductase (GR) and glutathione S-transferase (GST)) and the concentration of the micronutrients Fe, Cu and zinc (Zn) in breast milk. Breast milk samples were collected from 108 mothers (7–10 days postpartum, transitional milk). The samples were grouped into three groups according to the number of pregnancies (one, two and three or more pregnancies), also grouped according to the body mass index (BMI) suggested by the World Health Organization (WHO) in underweight, normal weight, overweight and obese. Breast milk Fe, Cu and Zn concentrations were determined by atomic absorption spectrophotometry and the activity of the antioxidant enzymes was determined by spectrophotometry. An increase in GPx, SOD and GST activities in relation to the number of pregnancies was found ($p = 0.05$, $p = 0.04$ and $p < 0.01$, respectively). An inverse relationship between GST activity and BMI was found ($p = 0.05$). A positive correlation was observed between Cu and Zn concentrations ($r = 0.52$, $p < 0.05$). A negative correlation was found between Cu concentration and catalase activity ($r = -0.22$, $p < 0.05$); Fe content was negatively correlated with GPx and GST activities ($r = -0.32$, $r = -0.22$, respectively, $p < 0.05$). The activities of antioxidant enzymes (GPx, SOD and GST) may be affected by the number of pregnancies and contribute to prevent oxidation of nutritional molecules in breast milk.

Introduction

Breast milk provides nutrients, antioxidants and microelements for the child's proper growth and development [[1], [2], [3], [4]]. Trace element concentrations change with the mother's environment and diet [5,6]. A relationship between microelement concentrations and antioxidant enzymes in breast milk has been reported [1,4]. The antioxidant system found in breast milk includes superoxide dismutase (SOD-E.C.1.15.1.1)) [7,8], catalase (E.C.1.11.1.6) [2,9], glutathione peroxidase (GPx-E.C.1.11.1.9) [2,9], glutathione reductase (GR-

E.C.1.6.4.2) [2,10], and glutathione S-transferase (GST-E.C.2.5.1.18) [2]. Zinc (Zn) participates in ~100 catalytic enzyme sites, in cell membranes and nucleic acids [11]. Infants have low capacity to regulate Zn absorption; however, breastfed children do not suffer from Zn deficiency [12]. Insufficient Zn consumption may cause nervous system and growth defects during the first months of life [13]. Zinc breast milk concentration decreases from early breastfeeding and stabilizes at the third month [14]. Copper (Cu) is essential in formation of bones, myelin, collagen, neuropeptides, hemoglobin and contributes to the electron transport chain [13,15]. Few studies report Cu toxicity in infants, attributed to regulation of Cu homeostasis at an early age [12]. Iron (Fe) content in breast milk is bound to lactoferrin [12]. Breast milk is low in Fe (0.2–0.5 mg L^{-1}). Supplements are recommended from the fourth month of lactation to prevent Fe deficiency, which can affect the infant's cognitive development [16,17]. However, excess Fe may reduce absorption of Cu [18] and promote growth of pathogenic bacteria, modifying the infant's microflora [17,19]. High concentrations of Fe and Cu can increase reactive oxygen species (ROS), associated to biomolecules' oxidation [20].

This study aimed to assess the relationship between antioxidant enzymes activity and trace element concentration in breast milk, as well as the relationship between the maternal characteristics, micronutrients and the activity of antioxidant enzymes of healthy women.

Section snippets

Sampling

Breast milk samples (n = 108) were obtained from healthy women from Baja California Sur, Mexico, during the second week postpartum (transitional milk). The samples were grouped into three groups according to the number of pregnancies (one, two and three or more pregnancies), also grouped according to the body mass index (BMI) suggested by the World Health Organization (WHO) in underweight, normal weight, overweight and obese. The milk samples were taken before the first breast feeding during…

Results

Maternal anthropometric characteristics are display in Table 2, grouped according to the number of pregnancies. Table 3 shows antioxidant enzyme activities and concentrations of Zn, Cu and Fe clustered by number of pregnancies. Significant differences in the activity of GPx, SOD and GST in relation to the number of pregnancies were found. The highest GPx

activity (0.08 U mg^{-1} protein) was observed in women with 3 or more pregnancies; significant differences were found between women with two…

Discussion

According to WHO, breast milk is the best source of nutrients during the first six months of life [29] and has been supported by evidence that breastfeeding reduces the risk of morbidity and mortality in the infant, in addition to improving growth as well as the development and modulation of the immune system [30]. Knowing the concentration of macronutrients and micronutrients in breast milk and how these change during the different stages of lactation due to factors related to maternal…

Conclusion

Significant differences in the activity of GPx, SOD and GST in relation to the number of pregnancies ($p = 0.05$, $p = 0.04$ and $p < 0.01$, respectively) were observed in human breast milk; these can be attributed to the increase in metabolic rate during successive periods of pregnancy and lactation. In this study, there were no significant differences in the concentration of Zn, Cu and Fe that could be attributed to the number of pregnancies or BMI. A positive correlation was found between the…

Funding sources

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Declarations of interest

None.…

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> …The macronutrients, micronutrients, and bioactive substances in breast milk, together with the breastfeeding practice itself, may play a role. For example, the antioxidant nutrients, such as long-chain polyunsaturated fatty acids and antioxidant enzymes (superoxide dismutase, catalase, and glutathione peroxidase et al.), in breast milk may reduce oxidative stress which participates in the development of obesity (Castillo-Castañeda et al., 2019; Rodriguez-Palmero et al., 1999). Moreover, breastfeeding plays an important role in driving the transition toward the adult-like gut microbiota of

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...All elements (heavy metals and/or trace elements) can be defined as potential hazard elements (PHEs) (Abedi et al., 2020; Mousavi Khaneghah et al., 2020). For example, Fe and Co, Cr, Mn, and Zn are known as micronutrients at low concentrations, essential for starting enzyme activities (Castillo-Castañeda et al., 2019; Kuganesan et al., 2019). Although trace elements in low concentrations can

benefit human health, high concentrations can have adverse effects (Castillo-Castañeda et al., 2019; Kuganesan et al., 2019)....

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